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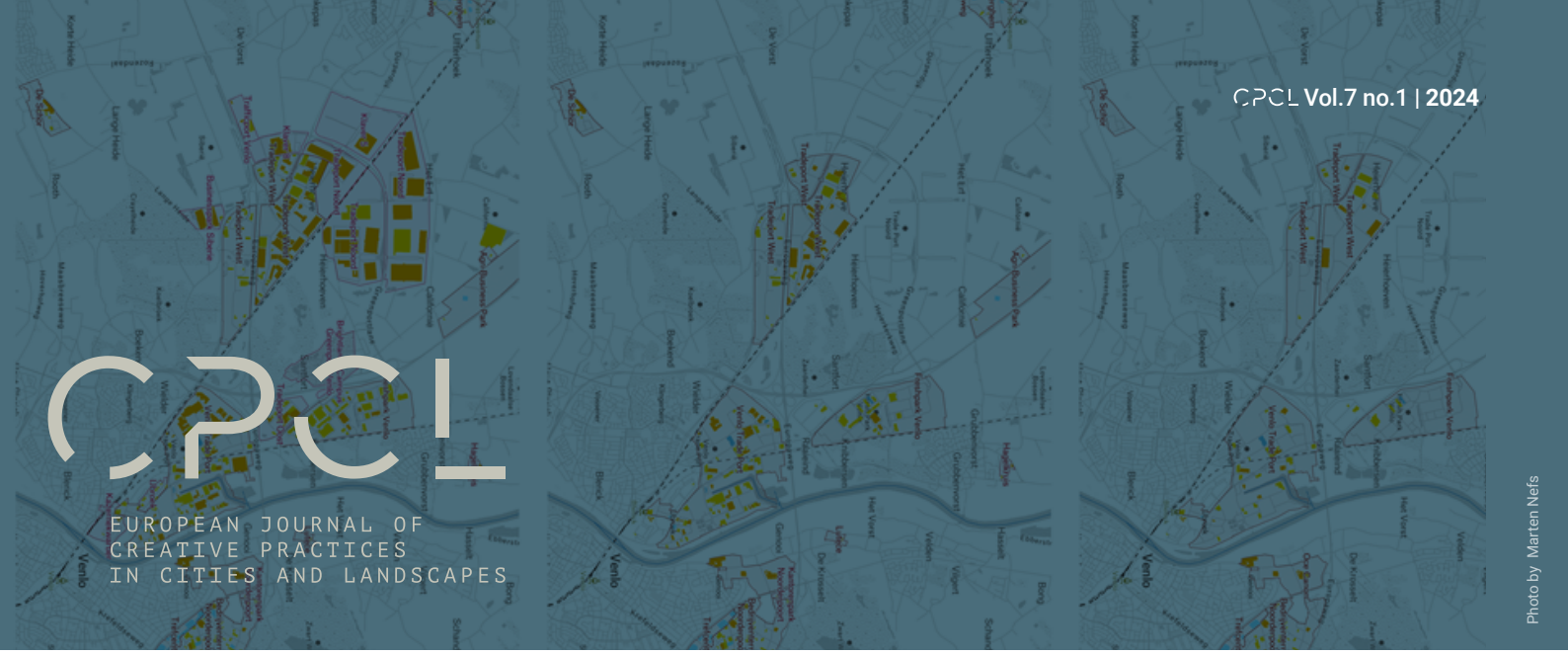

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MAIN SECTION

Counter-Mapping Spatial Footprint and Economic Activity of the Logistics Complex in the Netherlands

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ABSTRACT

The growing footprint and the economic importance of the logistics complex has become an urgent planning topic on policy agendas in Europe, particularly in the Netherlands and its neighboring countries. The rise of the XXL warehouse is an important element in this discourse. The discourse typically features many different growth figures and maps on a highly aggregated level, whereas the source data are often not made available. Policymakers and researchers, however, need a more detailed comprehensive overview to make adequate decisions, analyze developments over time, and communicate with the broader public. This paper presents the counter-mapping process of compiling, validating, and sharing such a cartographic overview, including different types and size classes of distribution centers (DCs). It discusses several methodological and practical obstacles, as well as the use of an interactive map and a dashboard to inform a broader public, and the representation of the time dimension. Furthermore, it discusses insights of the open-access cartography of the logistics complex that challenge the common narratives outlined by the market and government, and it provides recommendations for the updating and improvement of the dataset and visualization.

KEYWORDS

Counter-mapping; logistics; distribution center; open-access; interactive map

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Introduction

The growing footprint and the economic importance of the logistics complex have become an urgent planning topic on policy agendas in Europe, particularly in the Netherlands and its neighboring countries. Increasingly, negative environmental effects of logistics, such as congestion, air-, noise- and light pollution, experienced by local communities, influence the planning discourse on the development of distribution centers—DCs.[1] Simultaneously, the societal benefits of such developments in an increasingly scarce space have become more doubtful, particularly the employment generated in and around DCs.[2] The rise of the XXL warehouse, larger than 40.000 sqm, is an important element in this discourse. The discourse typically features many different growth figures and maps on a highly aggregated level[3], whereas the source data are usually not made available.

Policymakers, however, need a more detailed comprehensive overview to make adequate decisions, communicate with the broader public, and create a level playing field for developers. For example, the trend of logistics sprawl and environmental effects of warehouses[4] cannot be discussed and mitigated when regarded through aggregated regional figures. Furthermore, local planning issues often relate to development of one or a few warehouses at a specific location. Such developments—and protests from the side of the community— cannot be well assessed and evaluated without placing them in a detailed historical and spatial context. Additionally, to set up effective criteria for logistics developers across regions, as to create a level playing field and avoid a waterbed effect that pushes developments to suboptimal locations, policymakers first need to have a structural and detailed view (not anecdotical) on the trends in distribution center projects. Such a detailed view includes the location, geometry, and landscape integration of DCs. Researchers therefore also need detailed data to provide such (open-access) insights into the issues above.

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1 Aljohani and Thompson, "Impacts of Logistics Sprawl on the Urban Environment and Logistics: Taxonomy and Review of Literature"; Yuan, "Environmental Justice in Warehousing Location: State of the Art."

2 Nefs, van Haaren, and van Oort, "The Limited Regional Employment Benefits of XXL-Logistics Centres in the Netherlands"; Tabak, "Boxes, Boom and Benefits? Identifying Effects of XXL Distribution Centres on Regional Economies in the Netherlands."

3 Bak, *Logistiek Vastgoed in Cijfers 2021(Logistics Real Estate in Figures 2021)*; Stec Group and Denc, *Logistiek: Naar Een Kernwaarde in Regionale Ontwikkeling(Logistics: Towards a Key Value in Regional Development)*.

4 Krzysztofik et al., "Beyond 'Logistics Sprawl' and 'Logistics Anti-Sprawl'. Case of the Katowice Region, Poland"; Dablanc, Ogilvie, and Goodchild, "Logistics Sprawl: Differential Warehousing Development Patterns
in Los Angeles, California, and Seattle, Washington"; Strale, "Logistics Sprawl in the Brussels Metropolitan Area: Toward a Socio-Geographic Typology"; Heitz, Dablanc, and Tavasszy, "Logistics Sprawl in Monocentric and Polycentric Metropolitan Areas: The Cases of Paris, France, and the Randstad, the Netherlands."

Thus, the scientific and societal debate on the spatial effects and planning of the logistics complex depends highly on the quality of the available information. Even after 40 years of Gateway to Europe policies in the Netherlands and several discussions on their effectiveness[5], there is still not a detailed open-access overview of the building stock of logistics. Certainly, there are consultancy firms and brokers who gather these data for their own use and occasionally publish selections and reports on an aggregated level. This is not enough, however, to sustain independent research on the topic and to enable governments to make policies from an equal information position as the market. The logistics land market, if it is to be a free and well-functioning market, requires transparency through equally available information for all actors on the demand and supply sides.[6] Simultaneously, unequal information positions and unfounded claims are instrumental in the occurrence of logistics sprawl and the existing bias in the policy narrative of logistics.[7] A more equal and transparent information position thus seems necessary to make just planning trade-offs.

This paper introduces an open-access dataset of the logistics complex of the Netherlands in 2021.[8] Considering the available sources at that moment as well as the academic standards, it may be considered the best possible dataset in that year: (i) documented and shared according to the FAIR principles—findable, accessible, interoperable and reusable; (ii) consistently gathered from sources that will be available in the foreseeable future; (iii) dating back to before 1980 when the phenomenon of distribution centers emerged; (iv) featuring high detail across the Dutch territory usable for publication and analysis; (v) featuring various functional and size categories, as well as other variables through which the data may be filtered for specific analyses.

The data are gathered from open sources (OpenStreetMap, building administration - BAG, business estate data - IBIS) and a closed source (LISA company microdata), the latter obtained with the help of Stichting LISA, Frank van Oort (Erasmus School of Economics) and Hans van Amsterdam (Netherlands Environmental Assessment Agency, PBL). The data are compiled by the author, validated in collaboration with Thomas Bonte and Carlijn Ligterink (Vrije Universiteit Amsterdam), Vera Loefs and

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5 Nefs, Zonneveld, and Gerretsen, "The Dutch 'Gateway to Europe' Spatial Policy Narrative, 1980-2020: A Systematic Review"; Zande and Kreukels, "Rotterdam Network Mainport"; Kuipers et al., *Het Rotterdam Effect—De Impact van Mainport Rotterdam Op de Nederlandse Economie(The Impact of Mainport Rotterdam on the Dutch Economy)*; Van Duinen, "Mainport and Corridor: Exploring the Mobilizing Capacities of Dutch Spatial Concepts"; Van den Bergh, "Mainport Holland—Voor Onze Toekomst Bekeken Door 4 Vensters(Reviewed for Our Future Through 4 Lenses)."

6 Voss, "Transparency of Property Markets-the 1. National Level Market Report."

7 Nefs and Daamen, "Behind the Big Box: Understanding the Planning-Development Dialectic of Large Distribution Centres in Europe"; LeCavallier, *The Rule of Logistics—Walmart and the Architecture of Fulfillment*.

8 Nefs, "Dutch Distribution Centres 2021 Geodata."

Ana Luisa Moura (Deltametropolis Association). The data are available through a repository and they have been used for research, media articles, debates and education. Simplified versions of the data have been published on an interactive map and online infographics since 2019 to contribute to the public discourse. The data and visualization presented in this paper are focused on the planning discourse, whilst other (closed access) sources focus rather on the real estate perspective, based on other sources and sometimes featuring other types and size classes, as well as other time intervals.

The present dataset was compiled in the context of the PhD thesis Landscapes of Trade [9] to get an overview of the development of the logistics complex of the Netherlands since 1980. The thesis features various data visualizations demonstrating key parameters which appear in the discourse such as size, growth pattern, functionality, scale and employment of the logistics complex, on different scales. Other relevant aspects discussed include the relatively large spatial logistics footprint in The Netherlands compared to other countries, the spatial impacts, and the suitability of Dutch locations for certain types of logistics.

In the next section, the problem of logistics mapping is situated in the academic context of counter-mapping. In the third section, the available data sources on the logistics complex are introduced, along with their limitations. In the fourth section, the compilation method of the Dutch Distribution Center 2021 geodataset is presented and the challenges in this process are discussed. In section five the ways of publication and sharing of the data are discussed. Finally, insights of the open-access counter-mapping are discussed, and conclusions are drawn on the missing data and expansion of the dataset, as well as updating and continuity.

Counter Mapping of Powerful Systems Such as Logistics

The unequal information position regarding logistics introduced above is just one example of large powerful structures in society that lack transparency for sound democratic deliberation. There is a body of literature and practice in critical geography dealing with these issues. A concept within that field that is particularly relevant for this paper is counter-mapping. The concept was coined by Nancy Peluso regarding the indigenous mapping of forest territories, challenging the governmental figures in Indonesia. [10] Platform https://countermapping.com is inspired by Peluso's work and defines counter mapping as 'visual methods that explore & represent information, data and cultural practices.'

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9 Nefs, *Landscapes of Trade: Towards Sustainable Planning for the Logistics Complex in the Netherlands*.

10 Peluso, "Whose Woods Are These? Counter-Mapping Forest Territories in Kalimantan, Indonesia."

Bélanger[11] used the concept of counter-mapping in Ecologies of Power to understand the logistics and power structure of the US department of defense. The data-driven insights on the magnitude of the army's operations, for example in terms of fuel and costs, as well as mapping of the army's outposts in the Pacific and other regions of the world, has contributed to a more critical discussion on the ambitions and effects of US defense policy. Similarly, Hein[12] mapped the geography of the oil industry in the Netherlands, ranging from headquarters and refineries to petrol stations.

Also, in the field of geography of logistics efforts are made to increase insights into what is considered a rather closed sector.[13] For example, Coe & Hess[14] and Yuan[15] have mapped the employment and local impacts of large logistics centers in California, highlighting various inequalities and other issues. Various authors have written critical pieces on the logistics sector[16] , linking it to negative impacts of global trade, border effects, labor exploitation etc. Hesse presented a 'critical account of logistics operations and their relevance for the making (and unmaking) of territories.' An open-access highly detailed spatial overview of the growth pattern of logistics, however, is still lacking in many countries. The mapping described in the following sections aims to fill part of this gap in the Netherlands and provide insights that were not possible with the publicly available information before.

Compilation of Available Data on the Logistics Complex

The compilation and maintenance of a detailed dataset of distribution centers is challenging because of both the availability and the reliability of the data. The present compilation makes use of several sources (see flowchart in Figure 10.1):

1. *Open StreetMap* (OSM) is the most frequently updated open-access source of building geometry in high detail. Therefore, it is used as the basis for the building footprints at the starting point in the compilation. The categorization of the buildings in OSM (residential, industrial, etc.) however, is not reliable enough to use in the compilation.

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11 Bélanger & Arroyo (2016)

12 Hein (2018)

13 Frejlachová et al., *Steel Cities: The Architecture of Logistics in Central and Eastern Europe.*

14 Coe & Hess (2013)

15 Yuan (2018, 2019, 2021)

16 Khalili, *Sinews of War and Trade*; Cowen, *The Deadly Life of Logistics - Mapping Violence in Global Trade*; LeCavallier, *The Rule of Logistics—Walmart and the Architecture of Fulfillment*; Martin, "Desperate Mobilities: Logistics, Security and the Extra-Logistical Knowledge of 'Appropriation'"; Hesse, "Land for Logistics: Locational Dynamics, Real Estate Markets and Political Regulation of Regional Distribution"; Angélil and Siress, "Discounting Territory: Logistics as Capital Principle of Spatial Practices."

2. *Company microdata* of the Netherlands (2020 and 2017) can fill this functional gap. These proprietary data are not open-access and could be used for this research through an arrangement of the Erasmus University Rotterdam and PBL with Stichting LISA. The data provide a highly detailed overview of firm locations and their respective economic (sub)sector as well as employment numbers. Sometimes several (logistics) companies are registered in a single building. In such cases, the data is aggregated on the building level, summing up the employment of the companies and taking the function attribute of the largest company.
3. *Business estates* in the Netherlands are documented in the *Ibis* dataset. This open-access source is updated yearly with information supplied by the provinces. It includes existing and planned sites. As updates are performed on a yearly basis, there is some delay in for instance the number of hectares in the estate that are still available for development. It is a useful foundation for the compilation of the dataset, because it provides delineation and names of the business estates. Limiting the dataset to such estates was a key choice to keep it clean, since small firms (freelancers) located in residential areas are excluded in this way. It is possible that by doing this, small storage locations of city logistics are excluded as well. However, the research focuses on the logistics facilities located on business estates.
4. The *building administration* data of the Netherlands (BAG) is largely similar to OSM, but updated less frequently, at least until 2021. A great advantage of the newer versions of BAG is that they include construction years of the buildings. By joining this information to the data, it becomes possible to demonstrate the growth and growth pattern over longer periods of time. The small number of missing construction years was manually filled in using georeferenced historical maps.

Challenges in the Compilation Method

The step-by-step process of data compilation is shown in Figure 1, a flow chart describing the steps from the source data in the top to the resulting data in the bottom. First, the buildings are selected from the OSM data, when these are larger than 500 sqm and located on an Ibis business estate. Second, logistics companies are selected from the LISA data, following a list of SBI sector codes **(Table. 1)**. This selection is done in three groups: (A) trade, import and export; (B) transport and logistics services; (C) XL retail centers. The documentation on the repository provides more detailed information on the dataset. [17]

17 Nefs, "Dutch Distribution Centres 2021 Geodata."

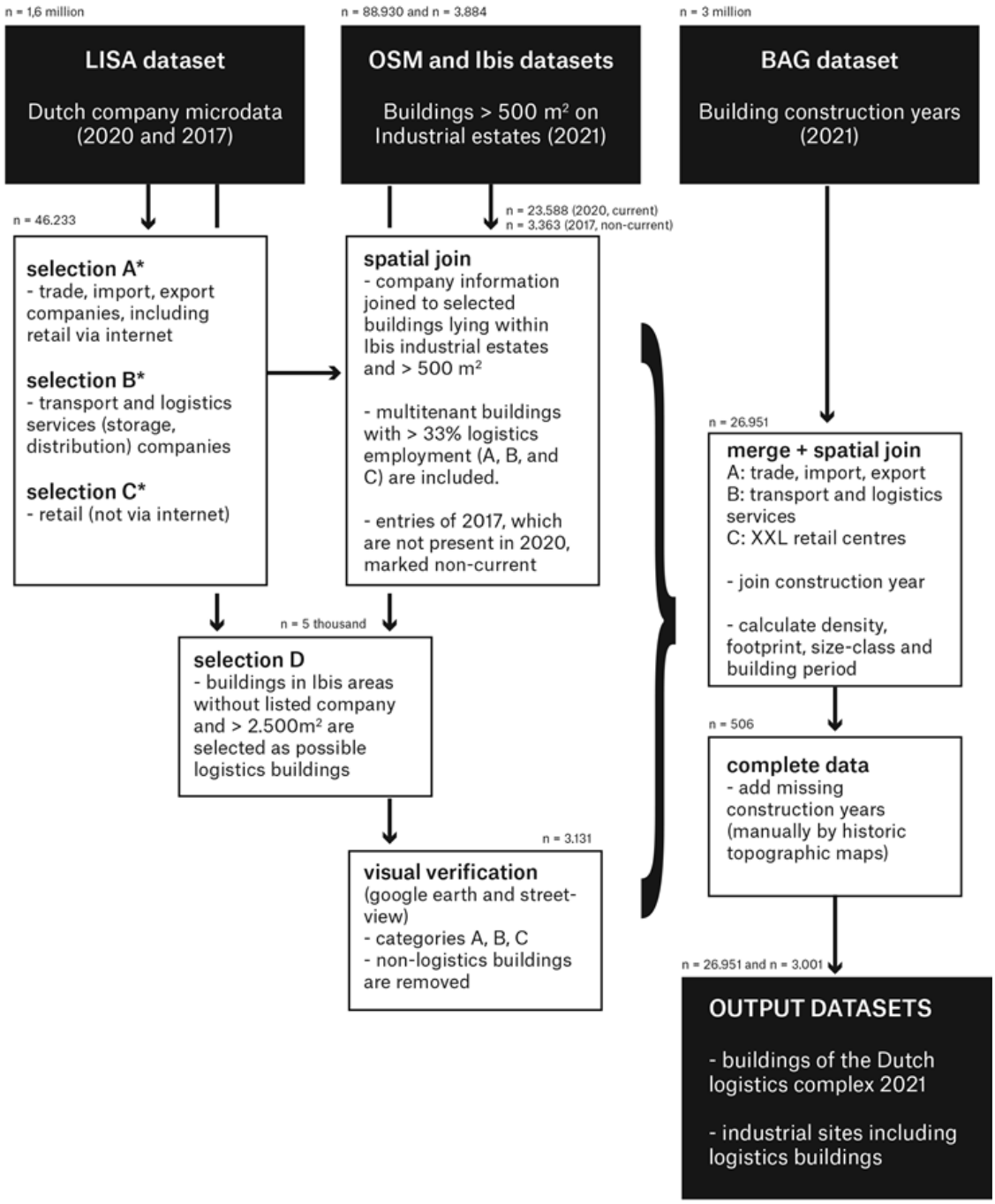

FIG. 1 Flow chart of data treatment.

An important step in the process is the inclusion of missing DCs that are not findable in the company microdata but are clearly visible in the field and on aerial pictures. Selecting the buildings from the first step that spatially match the logistics companies provides 80% of the resulting objects. The missing DCs, about 20% of the data including many recent XXL DCs, are selected by searching for buildings on business estates larger than 2.500 sqm—to maintain a workable number for manual verification—that do not have a LISA company entry. This selection is manually validated by using Google Earth and Streetview. Loading docks and Google company

SBI-2012 sector code (2-5 digits)	Description	Selection group (see flowchart) & Function in dataset
45.11.1	Import of new personal automobiles and light business automobiles	A: Trade, import, export
45.19.1	Import of new business automobiles	A: Trade, import, export
45.31	Wholesale and trading in automobile parts and accessories	A: Trade, import, export
45.40.1	Wholesale and trading in motorbikes and parts	A: Trade, import, export
46.2	Wholesale in agricultural products and livestock	A: Trade, import, export
46.3	Wholesale in food, drinks and tobacco	A: Trade, import, export
46.4	Wholesale in consumer goods (non-food)	A: Trade, import, export
46.5	Wholesale in ICT equipment	A: Trade, import, export
46.6	Wholesale in machines, equipment and accessories for industry and trade	A: Trade, import, export
46.7	Other specialized wholesale	C: XL retail center (ONLY IF located on business estate AND > 500 sqm)
46.9	Non-specialized wholesale	A: Trade, import, export
47	Retail	B: Transport and logistics services
47.91	Retail via postal order and internet	B: Transport and logistics services
49.20	Goods transport via rail	B: Transport and logistics services
49.41	Goods transport via road (excluding relocations)	B: Transport and logistics services
50.2	Maritime and coastal navigation (freight, tanker and towage)	B: Transport and logistics services
50.4	Inland navigation (freight, tanker and towage)	B: Transport and logistics services
51.2	Goods transport via air	B: Transport and logistics services
52	Storage and services for transportation	B: Transport and logistics services
53	Post and couriers	B: Transport and logistics services

TABLE. 1 List of SBI sector codes included in the broad definition of logistics in the dataset (see selection groups A and B in flowchart), as well as XL retail centers (selection C).

location information clearly indicate logistics in many cases. Often piles of construction materials or scrap, as well as Google company information, indicate that a building is used for other purposes, such as a construction or recycling company. Possible explanations for the lacking data are very recent constructions that have not been processed yet in the annual update, and the practice of leasing DCs from a third party or registering a DC at another company location.

The geodataset includes 26.951 logistics buildings in the Netherlands, built before November 2021, as well as the business estates they are in, and the outline of the East-Southeast (ESE) freight corridor of the Netherlands—the busiest logistics area of the country. The definition of the logistics sector elaborated and used in this research includes trade, import, export, wholesale, transportation, and warehousing activities, as well as e-commerce. Definitions of what a DC is are quite broad in the literature, usually including any building in which goods are (temporarily)

FIG. 2 Lacking logistics establishment data. Left: Tesla Motors Tilburg. Right: agrobusiness in Barendrecht. Source: Google Earth.

stored for commercial purposes in value- and supply chains.[18] Many real estate surveys focus on so-called XXL warehouses for logistics service providers, larger than 40 or 50 thousand square meters in ground floor space, for the purpose of market analysis.

This research, however, aims to assess the growth of the entire logistics complex, including medium and small storage buildings. To avoid irrelevant buildings such as small, dedicated office buildings and electrical installations, only logistics buildings larger than 500 sqm were considered in the data collection. Additionally, 4.533 large buildings of large retail centers on industrial sites were included, where consumers 'pick their own orders', such as construction materials stores; as well as 782 buildings including logistics co-activity, for example a hospital with a logistics company for medical materials. Manufacturing and recycling facilities, which often include logistics activities, are not included unless a separate logistics company is registered in the building. Depending on the focus of the analysis, a study may filter the data on, for example, XL (> 20.000 sqm) and XXL DCs (>40.000 sqm), used by traders and logistics service providers.

The dataset still underestimates the logistics spatial footprint, since often agricultural or manufacturing companies own logistics-style buildings and perform logistical tasks, without being registered as such (see examples in Figure 2). The actual use or vacancy of DCs at a certain moment, in terms of volume and market orientation of the goods, would be relevant to know but at present cannot be derived structurally from public nor proprietary data. This makes urgent public discussions on the scarcity of DC space more difficult, and the question which part of the logistics complex is needed to supply the Netherlands difficult to answer.

18 Keshavarz-Ghorabaee, "Assessment of Distribution Center Locations Using a Multi-Expert Subjective–Objective Decision-Making Approach."

FIG. 3 Lacking employment data of DCs (in grey).

Employment mapping of DCs

Employment has been a central argument in the policies facilitating logistics developments. Construction of transport infrastructure and DCs have often been promoted by claiming the creation of jobs. However, while this was a valid reason during periods of high unemployment, this has gradually become a moot point. The building boom of DCs since 2014 in combination with a tight labor market have led to permanent shortage of personnel, whilst attempts are being made to improve the productivity of the existing workforce through automation. Between 2015 and 2018 a Dutch employment agency observed increases in logistics job offers in six logistics regions of between 300 and 400%.[19]

In total, 896.912 people were employed in the sector in 2017 following the broad definition of logistics **(Table. 1)** used and calculated from the LISA microdata, or 11% of total Dutch jobs in that year. 70% of these jobs were performed inside a logistics building in a business estate as mapped above—the rest is arguably registered in office buildings of logistics companies and residential units of small entrepreneurs. Of total workers in the sector, 73% are men. Parttime workers, here defined as less than 12 hours per week, amount to 8% of men and 18% of women in 2017. Although

19 ManpowerGroup, "Transport En Opslag: Toenemende Schaarste Op Arbeidsmarkt(Transport and Storage: Increasing Scarcity on the Labour Market)."

exact mapping of employment data of individual companies is not permitted, a range of employment density could be published (see green shades in Figure 3). The detailed pattern of DC employment and its changes over time have also been published as a series of heatmaps with a 100x100m resolution.[20]

Employment numbers on logistics, although quite usable on the higher levels of scale (municipal or higher), have several blind spots on the level of individual buildings. As discussed above and shown in Figure 3, several recent XXL warehouses are not (yet) part of the LISA microdata. For analyses in the aforementioned PhD research, these had to be either excluded or provided with average employment numbers per function and size class. Another blind spot pertains to the highly fluctuating and unclear numbers of migrant labor, a considerable part of the labor force in logistics. The microdata should include workers from Dutch employment agencies, but it is unclear to what extent migrant labor is covered. The number of migrant workers in the Netherlands is estimated around 735 thousand in 2023, while research shows that the number of migrant workers can grow until 1.2 million in 2030. Especially in the ESE corridor, a large share of migrants works in DCs.[21] A third blind spot concerns the activities performed in DCs, the quality rather than the quantity of work. Often, besides logistical handling of goods, assembly and service tasks take place, which are not distinguished in the microdata, since the whole company falls under a single subsector (SBI).

Despite the image of logistics as a global growth sector, employment numbers develop quite differently across regions and areas. In the Netherlands as a whole, the logistics sector has grown slower than the total economy, in terms of employment. In some regions, especially in the ESE corridor, logistics employment has boomed and is becoming a heavy pilar of the regional economy. Also, on the local level there is much variation.

Despite the continuing growth in direct employment in logistics in the ESE corridor, this growth is characterized by a declining space quote: each newly built square meter of warehouse generates on average 25-30% less jobs than two decades ago[22]. This effect is strongest in logistics hotspot regions.

Digital Publication of Data and Maps

The dataset was published in different ways. There is an open-access repository on the 4TU Research Data portal, containing the data in various formats, accompanied by documentation and metadata. On this repository, versions can be controlled and updated, whilst the number of users is

20 Nefs, van Haaren, and van Oort, "The Limited Regional Employment Benefits of XXL-Logistics Centres in the Netherlands."

21 Roemer, *Jaarrapportage Arbeidsmigranten 2022*.

22 Nefs et al., 2023

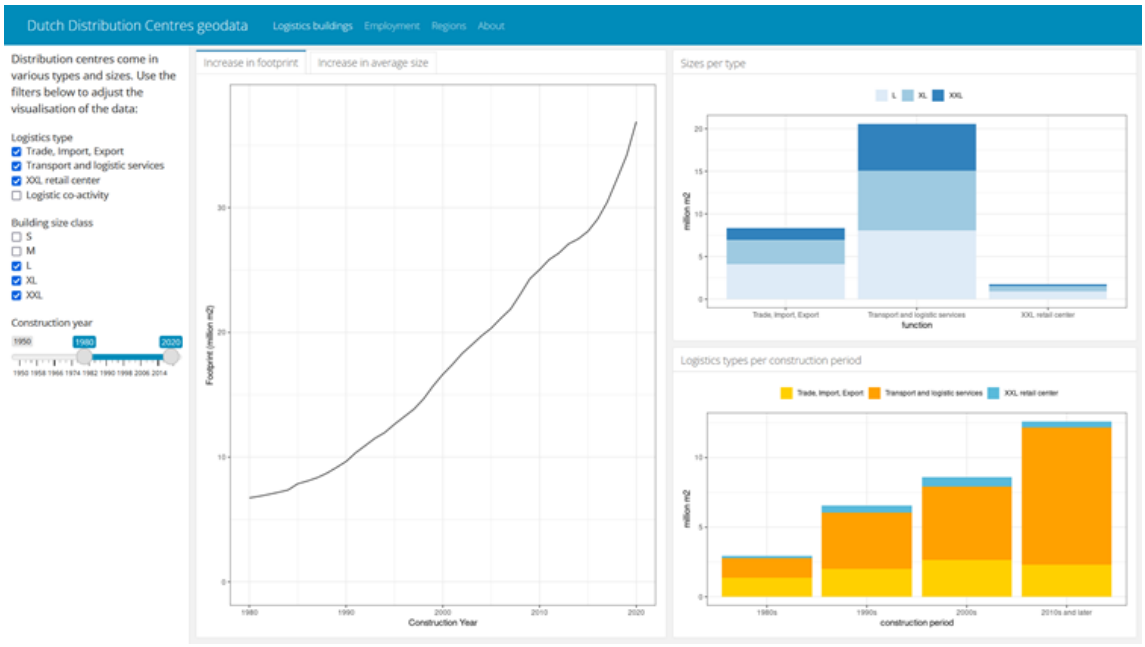

FIG. 4 Online dashboard. See https://mertennefs.shinyapps.io/distributioncentres_geodata_app/

documented. At the time of writing the data repository shows about 2000 downloads and 4000 views.

As not all potential users of the data, such as policy makers and planners, have data-analytical and visualization capabilities, a data dashboard has also been provided. Figure 4 shows one of the pages in this online dashboard application, featuring filters in the left sidebar (used here to exclude one type and the smaller and medium sized buildings). The charts update real-time according to the filters. Other pages visualize data regarding the employment in logistics buildings, as well as the regional differences (building footprint, footprint per capita, specialization rates etc.). The final page contains a brief explanation and links to the repository and online map.

An accompanying online map viewer, showing the rampant expansion of the logistics complex since 1980, had more than 5000 unique views since 2019. Figure 5 shows the web interface, including a slider tool for the timeline and preset buttons to zoom into particularly relevant locations. The scope of the data and viewer is the territory of the Netherlands. In the map a white area is highlighted: the ESE corridor, the main case study area in the forementioned PhD research,[23] The zoomed-out view features business estates colored by construction year and expected road congestion in the ESE corridor. The zoomed-in view features individual buildings colored by three dimensions chosen in a toggle menu: (i) types of

23 Nefs, *Landscapes of Trade: Towards Sustainable Planning for the Logistics Complex in the Netherlands*.

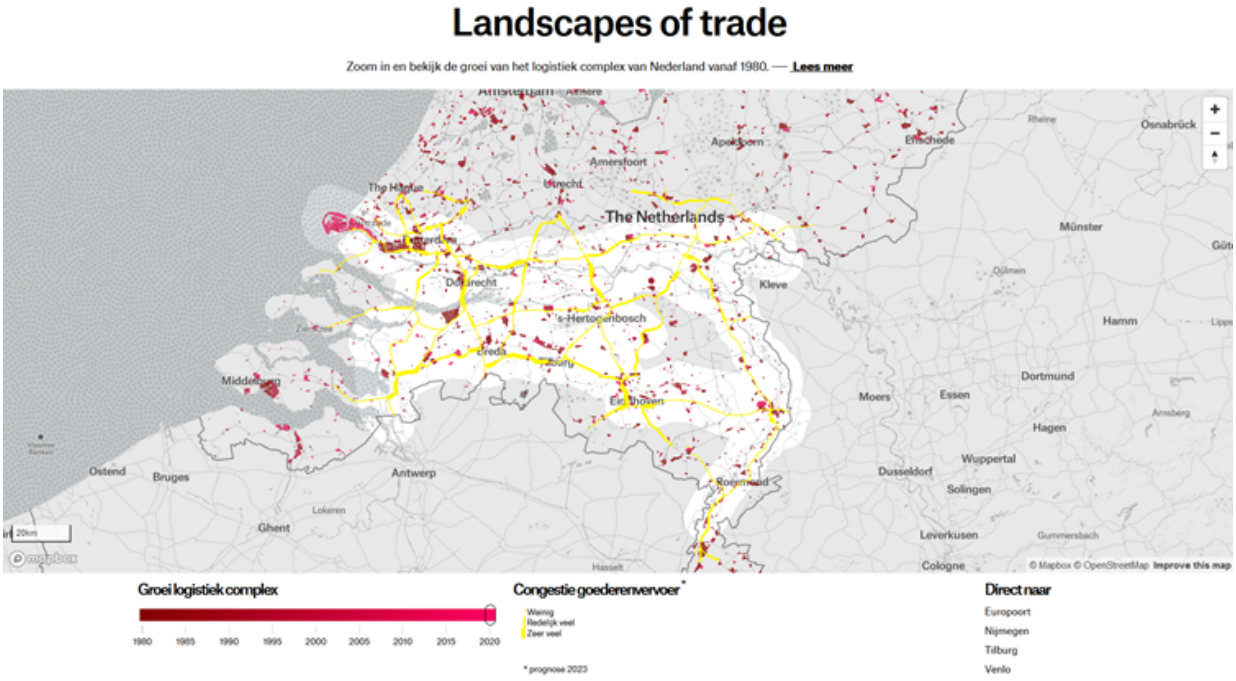

FIG. 5 Web interface of online interactive map. See https://mertennefs.eu/landscapes-of-trade/

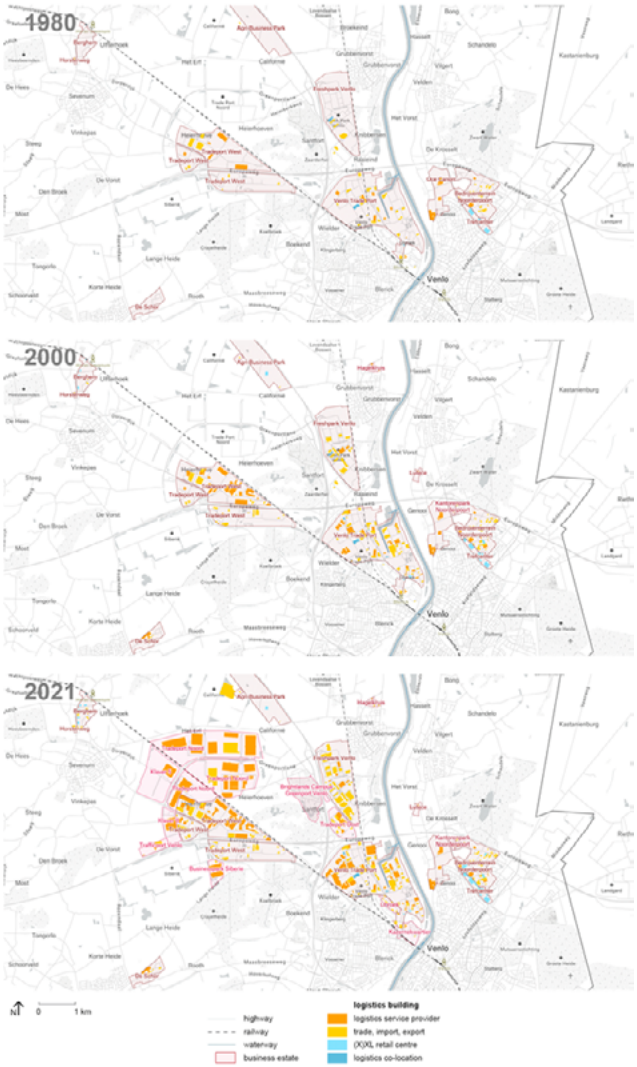

FIG. 6 Detailed panel map of Venlo 1980-2000-2021. See https://mertennefs.eu/landscapes-of-trade/

logistics activities (used in Figure 6), (ii) employment per square meter or (iii) size class of the buildings ranging from S to XXL. Figure 6 shows the zoomed-in view of the city of Venlo in 1980, 2000 and 2021.

Conclusion and Recommendations

Ongoing studies on the Dutch logistics complex and the recent discourse have pointed out that sustainable planning and development of the logistics complex requires open and equal information provision. Thus, it is crucial to introduce more centralized, independent, and open-access knowledge and information into the planning-development network. An informational level playing field would reveal good and bad practices; avoid undesirable 'quick flips'—opportunistic real estate transactions usually occurring in a situation of asymmetric information between private and public actors[24] ; demystify rhetoric fueled by 'not in my backyard' sentiments (NIMBY), lobbying, or other interests; and enable more conscious multi-level trade-offs.

The mapping of the logistics complex in the Netherlands, as described in this paper, has provided a more consistent (yet still partial) overview of this necessary information. The mapping, similar to counter-mapping by Bélanger e.a., has enabled insights that challenge the common views and narratives outlined by the market and governments, for example:

a) Despite the dynamic market cycles that dominate the news, the map and related infographics show a steady long-term growth of the logistics complex: a fourfold increase of the footprint since 1980. Stakeholders' claims over time that logistics growth has been coming to an end are thus not supported by the data.

b) The map shows that the logistics complex consists, besides the (X) XL warehouses that dominate the debate, for a larger part of small and medium size buildings, which are not being discussed. These smaller buildings, however, represent a larger share of the logistics workforce than the larger DCs.

c) Although much of the discussion focuses on logistics hotspots, the map shows that besides concentration there is also a strong pattern of dispersion or sprawl in less suitable areas.

d) The boom of logistics real estate has obviously generated jobs locally, but there are also locations where the logistics sector is moving away. Nationally, the sector lags compared to other sectors in the economy.

e) Contrary to many claims, regions facilitating development of XXL logistics parks have not attracted related manufacturing, R&D and

24 Nefs and Daamen, "Behind the Big Box: Understanding the Planning-Development Dialectic of Large Distribution Centres in Europe."

other desired activities close to those parks. These regions lost more tech-manufacturing and agro-food jobs than other regions.[25]

The full potential of the data is yet to be explored, in combination with other sources. Combining distribution center data with other data on, for example, production facilities, types of land use, urban density, infrastructure capacity and usage, different types of nuisance, biodiversity as well as environmental restrictions, may provide many insights that are useful in the policymaking process around logistics. Further studies are needed that follow such multifaceted and multidisciplinary approaches, to find spatial correlations and their underlying mechanisms.

In the described data, three relevant aspects of the growing logistics complex are still lacking. First, the territorial expansion of the logistics building footprint is only mapped within the Netherlands, while we know the artefact of the logistics complex stretches across national borders. At least Belgium and North-Rhine Westphalia should be added, from a Dutch perspective. There are several academic projects focusing on harmonization of data across borders (e.g. https://www.espon.eu/events/mapping-cross-border-interactions-along-borders-towards-novel-data-hub-eu-border-regions) and mapping cross-border phenomena such as water management (https://www.waternewseurope.com/the-netherlands-and-belgium-develop-cross-border-water-maps/). Closer cooperation between the Dutch Topsector Logistiek and their equivalent abroad could make this possible for logistics – such as VIL and VLAIO in Belgium. Second, the employment figures do not yet provide an overview of the proportion of labor with a fixed contract, flexible labor via agencies, and flexible labor from abroad (migrant labor). Reports suggest that in many distribution centers two thirds of the workforce consist of migrant labor, whilst they raise questions regarding housing and exploitation issues. Third, there is a lack of information on the exact activities and goods inside DCs. The current dataset of this paper is based upon a single company subsector per building, for example 'transport by road' or 'warehousing and logistics services.' In practice, however, manufacturing and service tasks in the supply chain increasingly take place in warehouses as well, known as value-added logistics (VAL). Another relevant dimension here is to what extent the goods stored and handled in the DC are oriented to the domestic or foreign market. [26] Including these three aspects, by gathering existing data and stimulating (or forcing) companies to provide (anonymized) data, would greatly improve insights for planners.

Nevertheless, given the detailed availability of information in the dataset discussed in this paper, relevant insights and information tools can already be provided for planning and development. It is up to local and

25 Nefs et al., 2023

26 Acocella, Cruijssen, and Fransoo, *Warehousification: Recommendations for the Future of Big Box Warehouses in the Netherlands*.

regional governments, as well as policy advisers, planners, designers, and developers, to apply the information and insights in practice and help update them by providing feedback and sharing practical experiences. A structural effort, however, is also needed to maintain the dataset and guarantee its relevance over time. At present, there is no arrangement for this. The author of the paper may attempt to update the data every couple of years, obtaining the necessary company microdata and performing the manual checks as described in the compilation method. Another possibility would be for national organizations, such as Dutch Statistics or the Environmental Assessment Agency (or even EU wide such as EUROSTAT), to assume the responsibility to fund, compile, validate and distribute the data open-access. Such organizations currently have limited means to enforce mandatory data submission by companies or governments, as is standing practice in e.g. the agricultural sector. New legislation would be required to make this possible. Collaboration in the updating and evaluation of the dataset may also improve the current sector definition, choice of size classes, aggregated function types and other functionalities. Such efforts would ensure that the Netherland, as a self-proclaimed logistics giant and 'gateway to Europe', maintains a transparent overview of its logistics complex.

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