

Diachronic and synchronic analysis of industrial-urban spaces: developing an urbanity indicator. A 170-year study of the Greater Region.

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Industrial-urban areas, urbanity, transition, long period, urban growth, cartography

Summary

Industrial-urban areas, often referred to as “mining towns”, bear witness to a perfect combination of industrialization and urbanization (Roncayolo, 1998a). Developed around village cores, these areas are characterized by high density but low socio-economic diversity. These characteristics made them vulnerable to the industrial restructuring of the 1970s. The aim is to develop a statistical indicator to better define these areas and complement landscape approaches. The methodology is based on demographic data collected over a very long period of time, combined with socio-economic data to create an urban character indicator. The results enable us to differentiate industrial-urban areas from other urban areas, providing a better understanding of their development and characteristics. The study focuses on the Greater Region, a cross-border cooperation area representative of industrial history and urban growth in Western Europe.

Introduction

Over the past two centuries, the interplay between industrialization and urbanization has given rise to new urban forms, often referred to as "mining towns" (Roncayolo, 1998a). These industrial-urban spaces are characterized by high population densities but low socio-economic diversity, distinguishing them from traditional urban areas. This lack of diversity made them particularly vulnerable during the economic and social crises of the 1970s industrial restructuring (Edelblutte, 2010). While previous research has defined and modeled these spaces through a landscape approach (Edelblutte, 2003), this study aims to complement that work by developing statistical indicators to better classify and understand them.

The Greater Region¹, a cross-border area encompassing Wallonia (Belgium), Luxembourg, the German states of Saarland and Rhineland Palatinate, and the former French region of Lorraine, serves as the study area. This region is representative of Western Europe's industrial history and urban growth, as all four areas experienced the progressive transfer of British industrial technologies from the 19th century onward. The presence of comparable industrial-urban spaces on both sides of the borders makes it an ideal case study for refining urban typologies.

Our approach integrates both diachronic and synchronic analysis. Using demographic data, the diachronic analysis enabled a cartographic representation of urban growth over a long period, from 1840 to 2020. Through a synchronic approach, the collection of socio-economic data allowed us to develop an urbanity gradient. The method for creating this indicator draws on L. Wirth's work, which defines a city's urbanity as a combination of density and diversity² (Wirth, 1938). A low urbanity gradient thus helped differentiate industrial-urban spaces from other urban areas that existed prior to the Industrial Revolution.

Representing urban growth over the long term: 1840–2011

Defining Temporal Boundaries

The diachronic analysis covers 170 years of urban growth, divided into two distinct periods. The first period spans from 1840 to 1970, characterized by the spread of industrial techniques across Europe (Caron, 1998; Plihon, 2016). This timeframe captures the industrialization process, which began at different times in each of the studied countries (Hubert, 2018; Vandermotten, 1985). The second period, from 1970 to 2011, encompasses the deindustrialization of steel and mining regions, driven by globalization (Bourquin, 2017; Plihon, 2016). The year 2011 was selected because it marked the completion of synchronized censuses across all four countries in the study area. Additionally, this date aligned with the availability of harmonized historical and economic data from 1840 to 2012 at the scale of the Greater Region (Helfer, 2008; Thomes and Helfer, 2010).

These two periods correspond to two distinct modes of urban morphogenesis and the reorganization of settlement systems. The first transformation, driven by urban growth beyond traditional city walls, is associated with the emergence of modern agglomerations and industrial-urban spaces (Roncayolo, 1998a). From the 1970s onward, the process of metropolization, coupled with the rise of individual car ownership, gave rise to a "new paradigm of urbanization" (Ghorra-Gobin, 2010). This shift contributed to the development of suburban rings and a new urban reality: cities with blurred boundaries, a concept F. Ascher sought to define with the term "metapolis" (Ascher, 1995; May et al., 1998).

Minimizing the MAUP effect: criteria for spatial unit selection

¹ The Greater Region is a cross-border area comprising Wallonia (Belgium), the Grand Duchy of Luxembourg, the German states of Saarland and Rhineland-Palatinate, and the former Lorraine region (France).

² This concept was later adopted by Lévy and Lussault in their definition of urbanity (Lévy and Lussault, 2003, pp. 966–967).

In recent history, the various national and regional contexts³ within the study area have implemented significantly different policies for rationalizing local government structures. This has resulted in administrative units of widely varying sizes (Evrard and Schulz, 2015; Wollmann, 2009). One initial solution was to replace the very small municipalities in France and the state of Rhineland-Palatinate with their respective intermunicipal boundaries (Figure 1a). However, this approach presented two spatial aggregation issues: the small size of Luxembourgish municipalities remained unresolved, and some French public establishments for intermunicipal cooperation (EPCI) were found to be as large as German *Kreis* districts. Another challenge was the obscuring of medium-sized towns in France within sometimes very large intermunicipal boundaries—a situation not observed in Rhineland-Palatinate, where the *Verbandsgemeinde*⁴ system only applies to municipalities with fewer than 12,000 inhabitants⁵ (Rheinland-Pfalz, 2010).

An alternative solution involved replacing Luxembourgish and French municipalities with their corresponding cantons⁶ (Figure 1b). These new boundaries significantly reduced the spatial aggregation problem and showed greater similarity to the boundaries of *Verbandsgemeinden* in Rhineland-Palatinate, as well as those of municipalities in Saarland and Belgium. In France, a specific process was applied to large municipalities divided into multiple cantons: in these cases, cantons were merged to cover the municipal boundaries and part of the urban agglomeration⁷.

³ *Länder* pour l'Allemagne

⁴ Intercommunalité en Rhénanie-Palatinat.

⁵ *Vergandtsfreie Gemeinde, Große Kreisangehörige Stadt, Kreisfreie Stadt, Kreisstadt* sont des communes et villes de Rhénanie-Palatinat situées hors des obligations législatives visant à un regroupement sous forme d'association communale.

⁶ Cantons luxembourgeois actuels et périmètre des cantons français avant la réforme de 2014.

⁷ Bar-le-Duc Nord et Bar-le-Duc Sud ; Verdun-Ouest, Verdun-centre et Verdun Est ; Nancy-Est, Nancy-Nord, Nancy-Ouest et Nancy-Sud ; Vandœuvre-lès-Nancy Ouest et Vandœuvre-lès-Nancy Est ; Toul-Sud et Toul-Nord ; Saint-Avold 1 et Saint-Avold 2 ; Thionville-Est et Thionville-Ouest ; Canton de Metz-Ville 1, Metz-Ville 2, Metz-Ville 3 et Metz-Ville 4 ; Épinal-Est et Épinal Ouest ; Saint-Dié-des-Vosges Ouest et Saint-Dié-des-Vosges Est.



Figure 1a - solution 1 (EPCI français et communes luxembourgeoises)

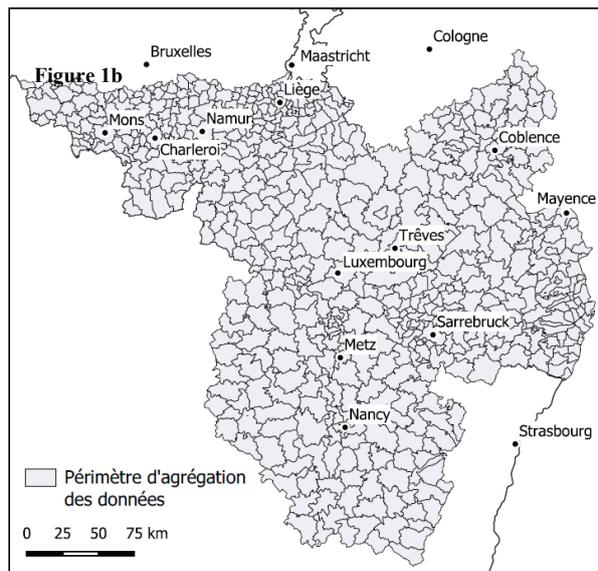


Figure 1b - solution 2 (cantons français et cantons luxembourgeois)

Figure 1 : Figure 1a – Boundaries (2021) of Luxembourgish municipalities, merged municipalities of Wallonia (BE) and Saarland (DE), Lorrain intermunicipal entities (EPCI, FR), and *Verbandsgemeinden*, *Verbandsfreie Gemeinden*, *Große kreisangehörige Städte*, and *Kreisstädte* of Rhineland-Palatinate (DE). Figure 1b – Boundaries (2021) of Luxembourgish cantons, merged municipalities of Wallonia (BE) and Saarland (DE), *Verbandsgemeinden*, *Verbandsfreie Gemeinden*, *Große kreisangehörige Städte*, and *Kreisstädte* of Rhineland-Palatinate (DE), and boundaries of Lorrain cantons prior to the 2014 reform (FR). Cartography: Nicolas Greiner (2025). Sources (2011): INSEE (FR), STATEC (LU), STATBEL (BE), Statistisches Landesamt Rheinland-Pfalz (DE), Statistisches Amt des Saarlandes (DE).

Method for harmonizing long-term demographic and socio-economic data

Demographic data were collected from national statistical agencies. For Belgium, historical data were obtained for the old municipalities⁸ that existed prior to the 1977⁹ reform. For the *Verbandsgemeinden*¹⁰ in Rhineland-Palatinate, data were provided by the regional statistical office¹¹. The obtained data were aggregated at the level of various categories of German municipalities¹², including *Ortsgemeinden*¹³. These data required further aggregation to align with the boundaries of their respective *Verbandsgemeinden*.

In the case of French cantons, the availability of historical demographic data aggregated at the current municipal boundaries was limited to the year 1876. Using the website *cassini.ehess.fr*, it was possible to obtain demographic data from earlier dates. By accounting

⁸ The territorial units in the study area correspond to administrative units reformed through territorial rationalization policies. Different strategies have been employed depending on the country and its planning traditions. Consequently, the study area includes three types of administrative units: in Belgium and the state of Saarland, these are the communes and *Gemeinden* resulting from mergers carried out in the 1970s; in Luxembourg, they are relatively small communes, despite some mergers in recent decades; and in France and the state of Rhineland-Palatinate, they are communal groupings (intermunicipalities in France and *Verbandsgemeinden* in Rhineland-Palatinate) (Wollmann, 2009).

⁹ Source: DB-GEO database (Statbel)

¹⁰ Local government association (intermunicipal system of Rhineland-Palatinate)

¹¹ *Rheinland-Pfalz Statistisches Landesamt*.

¹² These include *Städte* (cities), *Verbandsfreie Gemeinden* (municipalities outside an intermunicipal system), and *Ortsgemeinden* (municipalities that are part of a local government association).

¹³ Municipalities that are part of a local government association (*Verbandsgemeinde*)

for municipal mergers that took place between 1841 and 1876¹⁴, statistical processing allowed for the re-aggregation of demographic data from seven censuses¹⁵. The data were subsequently re-aggregated within the boundaries of cantons as they existed prior to the 2014 reform.

The greatest challenges involved processing data from Saarland due to limited accessibility of historical demographic data. However, such data were eventually obtained from federal archives¹⁶. Using legislative texts related to municipal mergers from December 19, 1973, the data were re-aggregated within the current boundaries of the *Gemeinden*¹⁷.

At the conclusion of the various processing phases, harmonization of the different censuses enabled the calculation of two demographic growth indices calibrated to the temporal boundaries of the analysis (Table 1).

Context	41 years		130 years						
France	2011 ⁽²⁾	1990	1968	1962	1954	1931	1901	1879	1841
Belgium		1991	1970	1961	1947	1930	1900	1880	1846
Rhineland-P.		1987	1970	1961	1950	1939	1905	1871	1835/46
Luxembourg		1987	1970	1960	1947	1930	1900	1871	1851
Saarland ⁽³⁾		1987	1970	1961	1951	1935/33	1895/1900	1871/75	1843/50

Tableau 1: Harmonization of censuses in the national contexts of the Greater Region from 1840 to 2011

Representing socio-economic and demographic dynamics from 1840 to 1970

The steel industry and coal mining were two key sectors for the regions studied until 1970. These industries exemplify the technological principles driving the major innovation cycles of the Second Industrial Revolution (Caron, 1998; Gille, 1978). A diachronic analysis of their evolution faced challenges due to the difficulty of utilizing numerous existing data sources. One reason is that many sources originate from amateur sites without clear methodologies for data collection. The second reason is the lack of harmonization across the study area, or simply the absence of data at the scale of one or more of its regions. The use of an online atlas¹⁸, hosted by the University of Luxembourg and resulting from scientific collaboration at the scale of the Greater Region, provided the only harmonized database over a long period.

¹⁴ <https://www.insee.fr/fr/statistiques/3698339>

¹⁵ Censuses 1841, 1846, 1851, 1856, 1861, 1866, 1872

¹⁶ For censuses 1843/50, 1871/75, 1895/1900, 1933/35, 1951, 1961 et 1970 : *statistische Ämter des Bundes und der Länder* (Statistische Bibliothek, 2021)

¹⁷ Municipalities of Saarland

¹⁸ <https://gr-atlas.uni.lu/atlas/fr/start.html>

The online atlas enabled the acquisition of geolocated data on the closure dates of coal mine shafts, calibrated for the period from 1840 to 1970¹⁹. The cumulative number of shafts completed by 1970 was calculated and aggregated within the boundaries of the reference administrative units. The atlas also provided geolocated data on active steel sites for the years 1912, 1965, and 2007. Each site includes technical information that helps measure the significance of the installation. The obtained values were summed and then aggregated within the current boundaries of the relevant administrative units.

Legend of listed sites (Thomes et Helfer, 2010)	Corresponding values summed and aggregated within the boundaries of the relevant administrative units (proportional symbols)
Blast furnace	1
Steelworks	1
Blast furnace, steelworks	2
Blast furnace, rolling mill	2
Blast furnace, steelworks and rolling mill	3

Tableau 2 : coding of steelmaking installations (Thomes and Helfer, 2010)

The socio-economic and demographic evolution of the 637 reference administrative units is linked to the major innovation cycles of the Second Industrial Revolution²⁰. The obtained data enabled the creation of a cartographic representation that combines the demographic growth index (1840 to 1970) with the cumulative number of mine shafts by 1969 and the number of active steelmaking sites in 1965 (Thomes and Helfer, 2010) (Figure 2).

Developing an urbanity gradient: variable selection

The variables available for constructing the urbanity gradient are limited by the cross-border nature of the study area and the scale of analysis. Among the usable data, the share of employment and higher education graduates can provide insights into the concept of diversity, the lack of which characterizes industrial-urban spaces (Edelblutte, 2010). However,

¹⁹ A number of shaft sinkings predate 1840. In these cases, the sinkings are included in the group of shafts that closed before 1900.

²⁰ The textile industry was one of the major industrial activities of the 19th and 20th centuries and was responsible for significant demographic growth in many regions. While data on the textile industry is available in the thematic atlas, the lack of precise dates prevented its integration into the diachronic analysis.

employment census protocols vary from one statistical agency²¹ to another, making harmonization challenging but feasible.

The study area is also characterized by a gradual increase in cross-border commuting toward Luxembourg starting in the 1970s. However, for Luxembourgish municipalities, employment data—both by place of residence and place of work—only cover individuals residing in Luxembourg and do not include cross-border workers²². Other data on the origin of cross-border workers are updated annually but only indicate the municipality of origin, not the municipality of work²³.

Using data from the Luxmobil²⁴ survey in 2017, it was possible to calculate an approximate²⁵ prorated number²⁶ of cross-border workers in 2011 for Luxembourg's 48 most populous municipalities, coming from the three neighboring countries (Lambotte, Marbehan, and Rouchet, 2021). The data were subsequently aggregated at the level of Luxembourgish cantons.

The variable for higher education graduates is particularly difficult to obtain in the case of Germany²⁷, but the 2011²⁸ census provided this data at the level of German municipalities. A process of equivalency was then carried out for the qualifications from each country using the International Standard Classification of Education (ISCED)²⁹.

The various processes aimed at harmonizing the obtained variables resulted in cartographic representations for the period from 1970 to 2011 (Figure 4). Combined with population densities, these variables cover two of the three components of urbanity in a place: density and diversity (Lévy and Lussault, 2003).

Developing the urbanity gradient also involves narrowing the analysis to the urban areas within the study region, as the goal is to refine the typology of industrial-urban spaces and highlight their specific characteristics compared to other urban areas. The selection is based on population density, which is a defining element of urban spaces. To do this, the statistical distribution of population densities across the 637 reference administrative units is divided into quartiles. This discretization method is well-suited to skewed distributions and divides the

²¹ Contact with the Interregional Employment Market Observatory (IBA-OIE) (www.iba-oie.eu/fr/) seems to confirm the different employment census methods used by each national statistical agency: declarative method in France, calculation based on social security affiliation in Belgium or Germany.

²² <https://data.public.lu/fr/datasets/r/54b42c14-5932-49d8-a1bb-82b2253a47c0>

²³ <https://data.public.lu/fr/datasets/emploi-total-par-commune-de-residence-au-luxembourg-et-dans-les-pays-frontaliers/>

²⁴ Produced by the Ministry of Mobility and Public Works (Luxembourg). Data accessible in the following article: https://ubt.opus.hbz-nrw.de/opus45-ubtr/frontdoor/deliver/index/docId/1622/file/UniGR-CBS-Working_Paper_Vol.11.pdf

²⁵ An issue arose with the 54 least populated municipalities in Luxembourg, which the Luxmobil study groups into a single total. This resulted in a smoothed approximation per municipality of around 440 jobs at the workplace, including cross-border workers.

²⁶ The prorated distribution was applied using data from the IGSS (General Inspectorate of Social Security) in Luxembourg : <https://adem.public.lu/fr/marche-emploi-luxembourg/statistiques/statistiques/igss/Tableaux-interactifs-stock-emploi.html>

²⁷ Germany is a national context in which the federal states (Länder) have their own statistical agencies, and access to data varies significantly between them.

²⁸ In the case of Germany, the 2011 census is the only updated source for data on higher education graduates, as the COVID-19 pandemic delayed the planned 2021 census, which coincided with the timing of this study.

²⁹ <https://unesdoc.unesco.org/ark:/48223/pf0000220879> (UNESCO, ISCED)

population into classes of equal size. The advantage is that quartiles are less sensitive to extreme values, which is relevant here given the significant density disparities (min = 9 inhabitants/km²; max = 7,021 inhabitants/km²).

The quartile method groups 160 administrative units with a minimum density of 333 inhabitants/km² and a minimum population of 6,556 inhabitants³⁰. This selection aligns with the urban-rural classification developed by the European Commission, which defines urban areas as having a population density of at least 300 inhabitants per km² and a minimum of 5,000 inhabitants (European Commission, Statistical Office of the E.U., 2021).

Based on this selection, the urbanity index is calculated by multiplying the values related to population density (density) with the values related to the share of employment and the share of higher education graduates per inhabitant (diversity). The resulting product is then divided by three (Figure 6).

Representing and mapping urban transitions

The maps produced reveal the combination of urbanization and industrialization that characterized the development of new industrial-urban forms from the 19th century onward. The steel and mining areas experienced the highest demographic growth recorded in France during the analyzed period (Roncayolo, 1998b, p. 27). This significant growth is also observed in the Walloon industrial belt (Belgium), Luxembourg, and the Saarland region (Germany). Additionally, the growth of other industrial-urban areas can be identified, such as the textile industry valleys in the Vosges (east of Épinal) and the chemical industry corridor from Ludwigshafen to Mainz in Rhineland-Palatinate (Figure 2).

³⁰ *Ensdorf* in Saarland (2011)

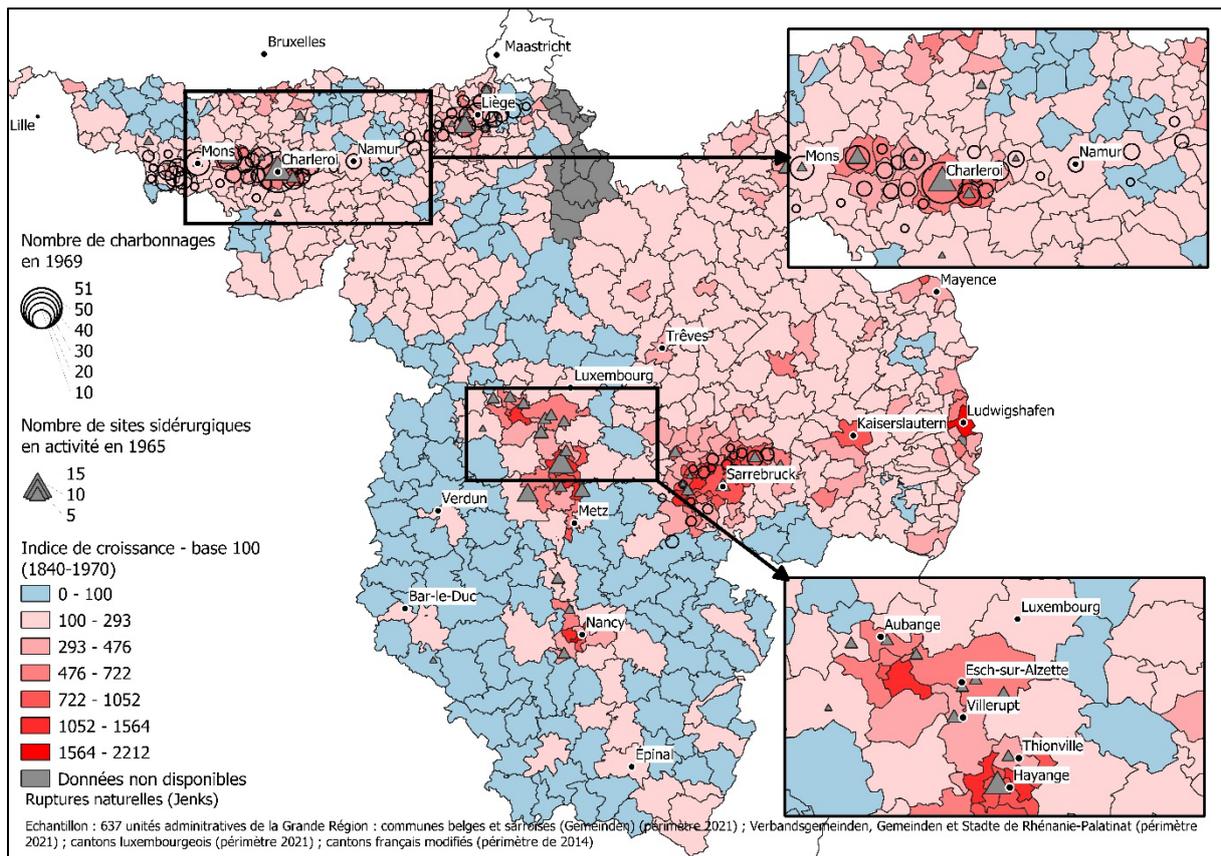


Figure 2 : Demographic growth index from 1840 to 1970 and industrial activities (coal mining and steel production). Demographic sources: INSEE (France), STATEC (Luxembourg), STATBEL (Belgium), Statistisches Landesamt Rheinland-Pfalz (Germany), Statistisches Amt des Saarlandes (Germany). Historical German sources (Saarland): Statistische Ämter des Bundes und der Länder, *Amtsblatt des Saarlandes* – Archive 1920–1998 (Christoph Gröpl, Universität des Saarlandes). Economic sources: Online Atlas of the University of Luxembourg (gr-atlas.uni.lu) – Paul Thomes & Marc Engels (2010) for steel production, Malte Helfer (2008) for coal mining. Base map source: F. Morel-Doridat (Université de Lorraine), updated by Nicolas Greiner (2021). Production: Nicolas Greiner (2025)

The growth indices observed from 1840 to 1970 contributed to the development of genuine steel and mining conurbations in regions rich in strategic deposits. Today, these conurbations represent the urban legacy of a form of urban growth that has now faded. The transformation of settlement systems is also evident in the sharp demographic decline in rural areas, which, along with immigration, served as a labor reservoir (Baudin, 1997).

While the location³¹ of steel and mining sites was associated with the highest growth indices from 1840 to 1970 (Figure 2), this relationship reverses between 1970 and 2011. During this later period, the most significant population declines occurred in the administrative units where former industrial facilities were concentrated (Figure 3).

³¹ Les sites sidérurgiques reprennent la localisation des communes.

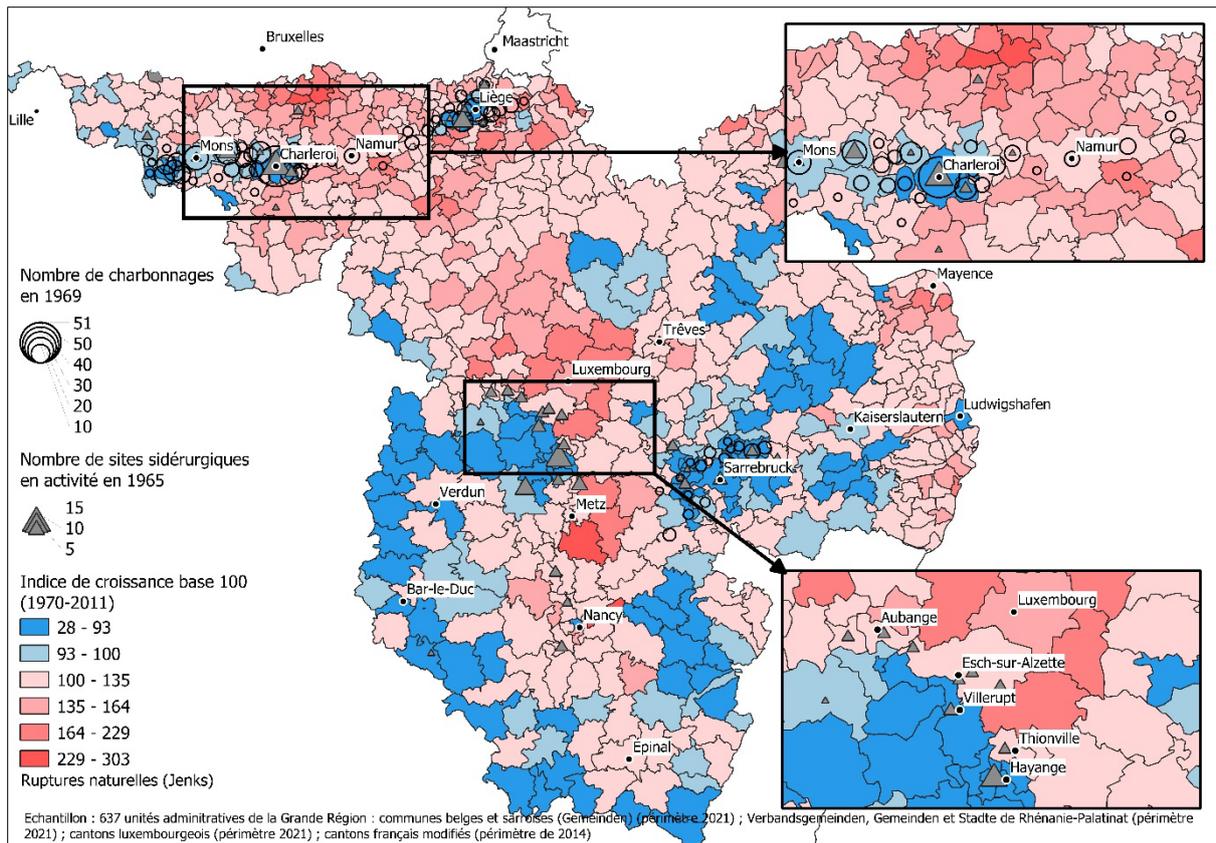


Figure 3: Demographic Growth Index from 1970 to 2011 and Industrial Activities (Coal Mining and Steel Production). Demographic Sources: INSEE (Fr), STATEC (Lu), STATBEL (Be), Statistisches Landesamt Rheinland-Pfalz (De), Statistisches Amt des Saarlandes (De). Economic Sources: Online Atlas of the University of Luxembourg (gr-atlas.uni.lu) – Paul Thomes & Marc Engels (2010) for steel production, Malte Helfer (2008) for coal mining. Base Map Source: F. Morel-Doridat (Université de Lorraine), updated by Nicolas Greiner (2021). Production: Nicolas Greiner (2025).

From 1970 onward, the suburban areas around major regional cities in Lorraine experienced demographic growth, ending the rural exodus observed between 1840 and 1970. This demographic growth in suburban areas is accompanied by a relatively high proportion of residents with higher education degrees (2011) (Figure 4). In contrast, formerly industrialized areas experiencing significant population decline have a low proportion of higher education graduates (2011). This decline is also associated with a reduced number of jobs (2011) in what were once the productive hubs of heavy industry in each national economy. The low rates of higher education graduates in these areas persist despite their proximity to large regional cities or metropolises (Figure 5).

Low rates of higher education graduates are also observed in Charleroi (Figure 4), an industrial city whose growth and decline indices closely resemble the typology of industrial-urban areas (Figures 1 and 2).

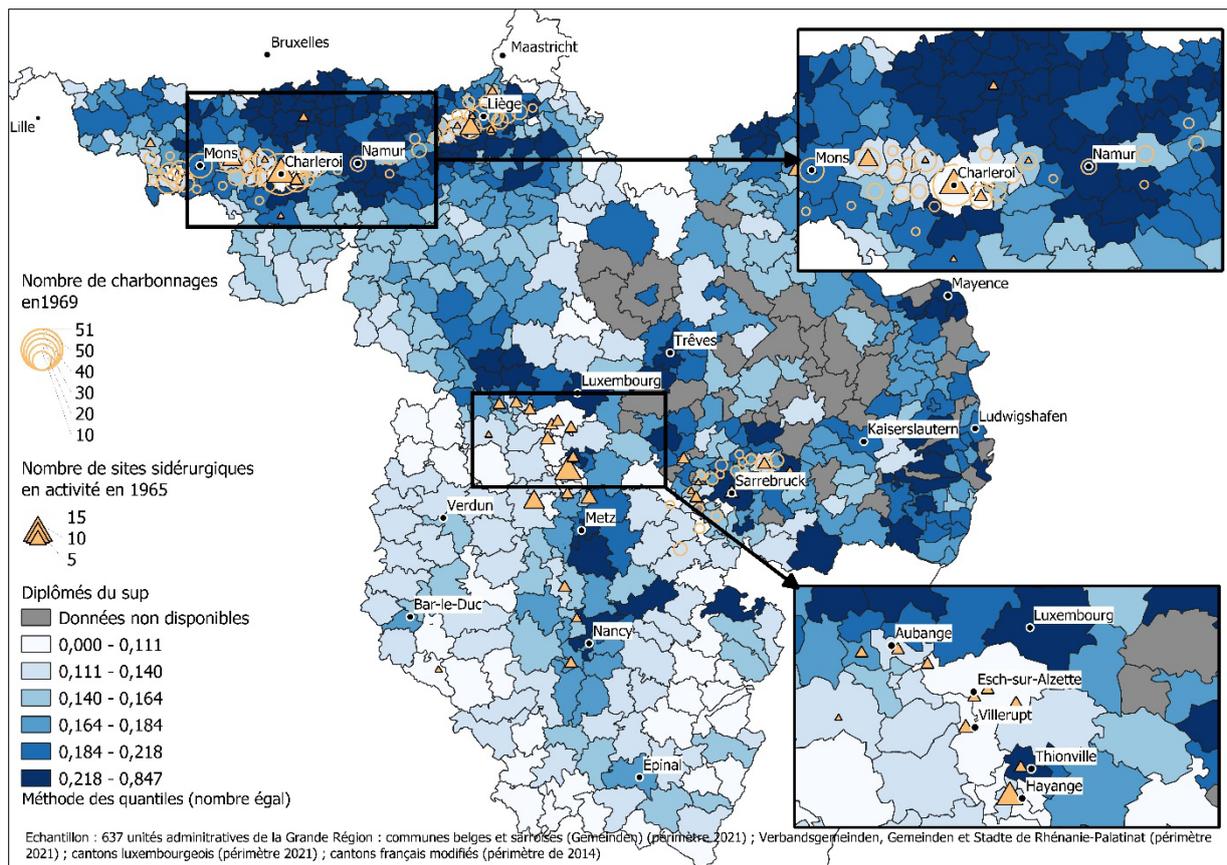


Figure 4: Number of Higher Education Graduates per Inhabitant (2011) in the Greater Region. Sources: INSEE (Fr), STATEC (Lu), STATBEL (Be), Statistisches Landesamt Rheinland-Pfalz (De), Statistisches Amt des Saarlandes (De). Economic Sources: Online Atlas of the University of Luxembourg (gr-atlas.uni.lu) – Paul Thomes & Marc Engels (2010) for steel production, Malte Helfer (2008) for coal mining. Base Map Source: F. Morel-Doridat (Université de Lorraine), updated by Nicolas Greiner (2021). Production: Nicolas Greiner (2025).

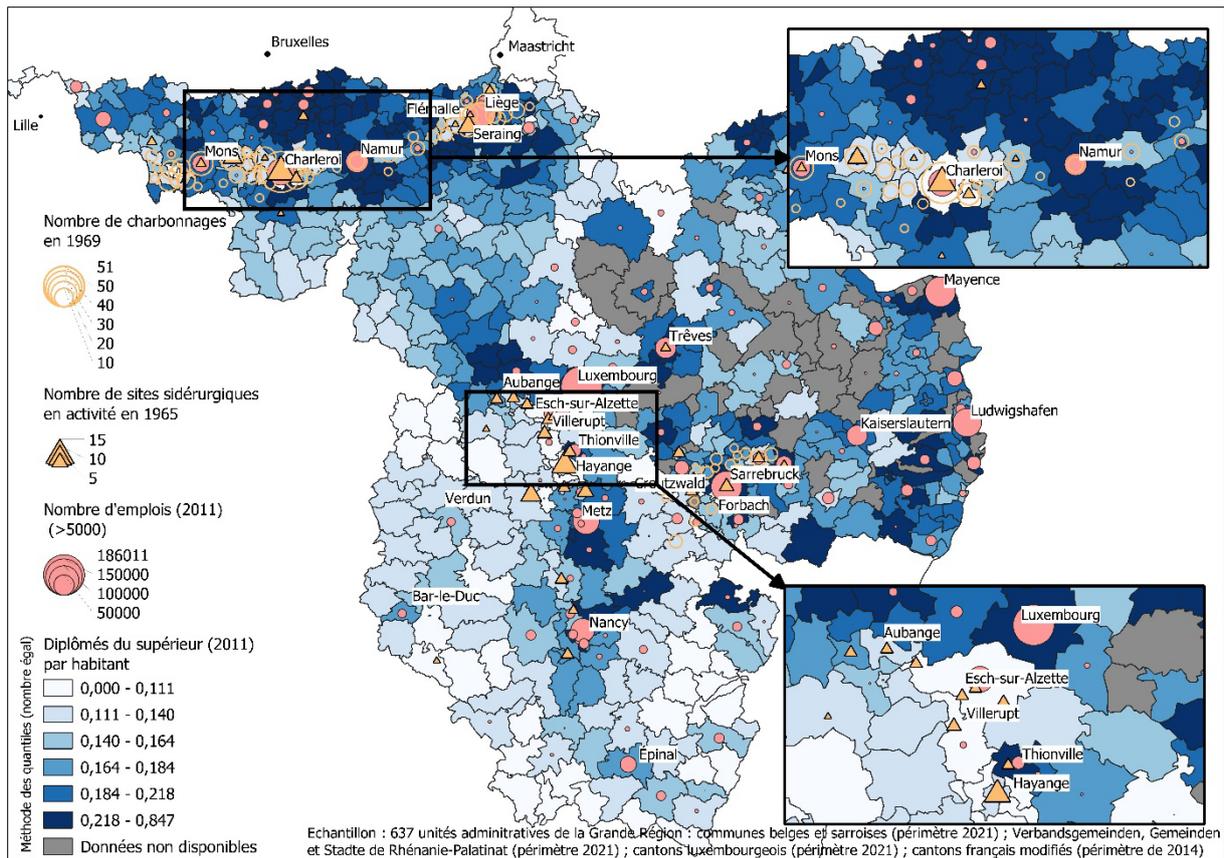


Figure 5: Number of Jobs in 2011 in the Greater Region. Sources: INSEE (Fr), STATEC (Lu), STATBEL (Be), Statistisches Landesamt Rheinland-Pfalz (De), Statistisches Amt des Saarlandes (De). Economic Sources: Online Atlas of the University of Luxembourg (gr-atlas.uni.lu) – Paul Thomes & Marc Engels (2010) for steel production, Malte Helfer (2008) for coal mining. Base Map Source: F. Morel-Doridat (Université de Lorraine), updated by Nicolas Greiner (2021). Production: Nicolas Greiner (2025).

The figure below illustrates the urbanity gradient developed for the 160 densest administrative units in the study area (Figure 6). The gradient is relatively high in major regional cities. Metz, Nancy, Luxembourg, Saarbrücken, and Liège stand out clearly. Charleroi and Mons, which are of comparable size, exhibit a lower urbanity gradient, a trend that can be linked to their industrial past.

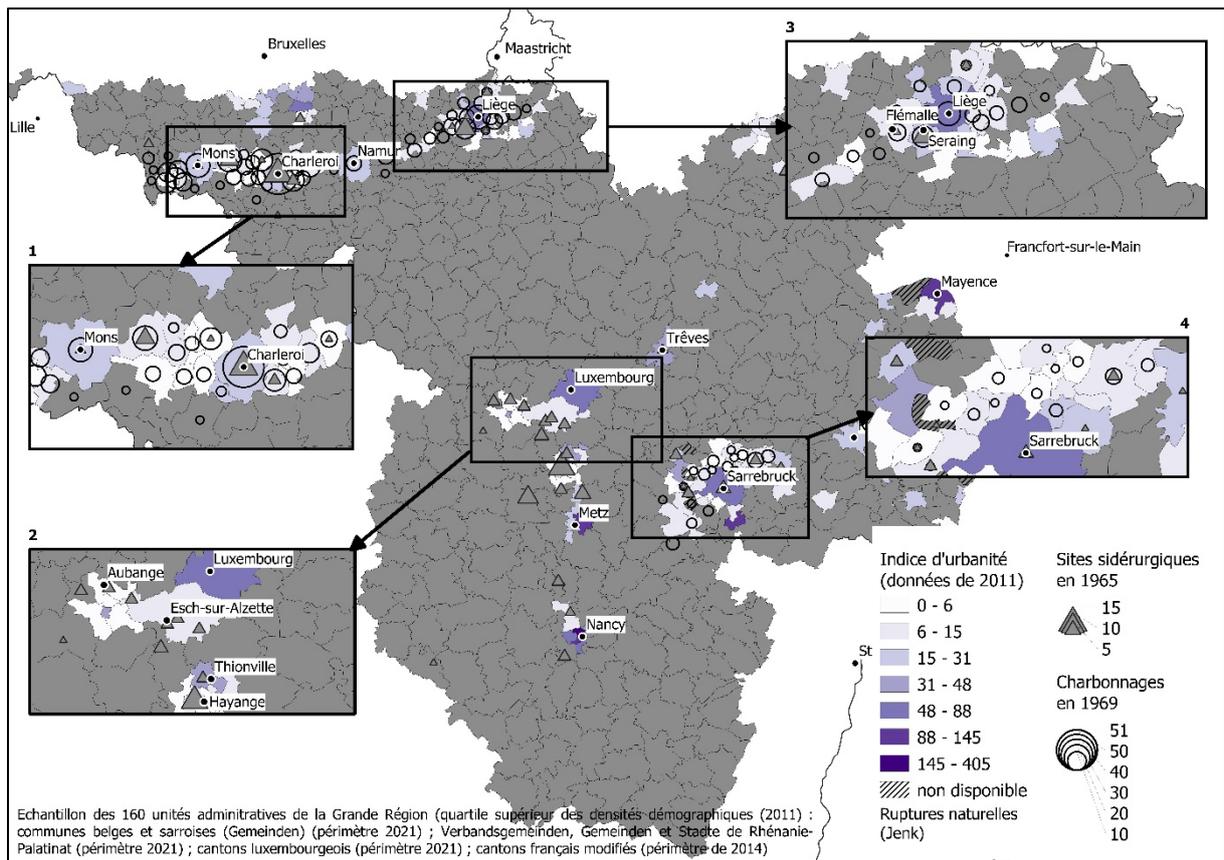


Figure 6: Urbanity Index and Industrial and Mining Heritage. Sources: INSEE (Fr), STATEC (Lu), STATBEL (Be), Statistisches Landesamt Rheinland-Pfalz (De), Statistisches Amt des Saarlandes (De). Economic Sources: Online Atlas of the University of Luxembourg (gr-atlas.uni.lu) – Paul Thomes & Marc Engels (2010) for steel production, Malte Helfer (2008) for coal mining. Base Map Source: F. Morel-Doridat (Université de Lorraine), updated by Nicolas Greiner (2021). Production: Nicolas Greiner (2025).

In Figure 6, industrial-urban areas are characterized by the presence of former steel and mining units combined with the lowest urbanity gradients. These urbanity levels contrast sharply with the relatively high gradients observed in urban areas of similar size located in Walloon Brabant near Brussels. Other configurations emerge, such as the canton of Longwy (small in size), located south of Aubange, which exhibits a relatively high urbanity gradient surrounded by areas of low urbanity (Box 2). A similar pattern is observed in Thionville compared to Hayange (Box 2). Exceptions are also noted, such as Namur, which has a relatively low urbanity gradient compared to other regional capitals. These results are surprising because Namur experienced positive demographic growth from 1970 to 2011, and its GDP per capita is significantly higher than that of Charleroi (INBW, 2016). Satellite observation reveals that the urban area of Namur covers only a small part of its very large municipal boundary. Considering only the urbanized part of each administrative unit, rather than the entire institutional boundary, could prevent such biases and contribute to more robust results. This adjustment might also explain—or fail to explain—the results for Longwy. It is worth noting that the university site of Belval in Esch-sur-Alzette was still under development in 2011. An analysis using updated data from recent censuses could assess the evolution of the urbanity gradient for this territory.

Discussions

Cities rooted in a centuries-old urban legacy

Stephan Jonas argues that the industrial age served as the link between the pre-industrial heritage and the contemporary post-industrial reality, transforming most European cities (Jonas, 1985). The historical embeddedness of "industrial cities" may have provided them with resources that ensured their ability to adapt during the transition of the 1970s. Metropolises and major regional cities have thus become, at all scales and with varying intensities, the "active context" for contemporary socio-economic dynamics (Ascher, 1995, p. 84).

Major regional cities were sometimes heavily industrialized, but their significance in the regional space long before the industrial age ensured the presence of a diversified socio-economic fabric, decision-making functions as regional capitals, and the presence of universities. Due to the greater diversification of their socio-economic fabric, inherited from a long urban tradition, large cities at the top of the urban hierarchy—whether regional or global—have been able to withstand the "shock" of transitions (Pumain et al., 2006). The development of an environment³² more conducive to innovation was thus observable during the Industrial Revolution. This was particularly true when economic activity was framed within a national context. The major city of an industrial region could become a hub for secondary technological innovations that enhanced the competitiveness of the regional industry, as seen in the technical improvements in metallurgy within the Liège and Lorraine basins (Hardy-Hémery, 2001).

The cases of Liège and Nancy illustrate the pre-existing advantages of industrial cities with centuries-old histories (Glaeser, 2006). Both cities faced significant socio-economic challenges due to the industrial restructuring of the 1970s (Cahen and Louis, 1990). However, the presence of a diversified economic fabric and, notably, the influence of long-established universities allowed these two cities—despite sometimes substantial demographic decline—to maintain their roles as major regional cities and adapt to an economy dominated by the tertiary sector and knowledge-based industries

The diversity deficit in industrial urban areas

While the continuity of the European city through pre-, industrial, and post-industrial layers may seem evident, this continuity can only be realized in places where these layers overlap. Such determinants relate to the trajectories of rupture observed in industrial-urban areas. The development of these areas—without pre-existing urban layers—represented a major obstacle to adapting to contemporary socio-economic dynamics. Their genesis and development were characterized by the combination of demographic growth and industrialization (Roncayolo, 1998b, p. 27). These agglomerations are thus defined by the omnipresence of an industrial sector around which urban space is organized. The modalities of such development differentiated this new type of space from urban areas predating the

³² In the sense of an "innovative environment", defined as the "combination, within a given geographic area, of businesses, training centers, and public or private research units engaged in a partnership approach [...] around innovative project(s)" (Uzunidis in Achermann, 2014, p. 12).

Industrial Revolution. In this regard, some authors deny industrial-urban forms the designation of "city" (Roncayolo, 1998a, p. 133), while others describe them as an anti-model of the city, closer to a "*worker conglomerate*" (Andrieux, Bergeron, in Edelblutte, 2010). Industrial-urban forms exhibit high densities that classify them as urban spaces but differ due to their low socio-economic diversity (Edelblutte, 2010).

These spaces therefore differ from large regional cities or medium-sized *Ancien Régime* cities, which benefited throughout the Industrial Revolution from a diversity of actors, resources, and wealth constitutive of their urbanity (Lequin, 1998). The low socio-economic diversity of industrial-urban forms is the source of a deficiency in urbanity, observable on maps (Edelblutte, 2010). This deficiency exacerbates the effects of the economic and social crisis induced by the industrial restructuring of the 1970s. These restructurings created a "functional void" within urban spaces designed by and for socio-economic dynamics inherent to the innovation cycles of a now bygone era (Edelblutte, 2010).

Urbanity is tied to places of centrality where a diversity of functions intersect. The contemporary city thus experiences a gradual loss of urbanity from the center to the periphery (Lévy and Andrieu, 2007). This progressive loss implies the idea of a decreasing gradient, which can be disrupted by other factors such as the historical concentration of working-class populations (Lévy and Lussault, 2013). Industrial basins, despite their "mass," generate a low level of urbanity (Lévy and Andrieu, 2007). In our analysis, the presence of industrial-urban spaces indeed disrupts the decreasing model of urbanity.

The diversity of observable situations

The size effect is also a factor of urbanity for a given place (Lévy and Lussault, 2013). However, a comparison between the major cities in the study area reveals that urban spaces like Charleroi exhibit—a population being equal—a lower level of urbanity than other regional capitals. These results raise questions about the existence of a trajectory effect in the observed urbanity gradients. Charleroi falls into a hybrid category of places that experienced very rapid demographic growth in the 19th century, reaching over 100,000 inhabitants³³ in just a few decades. Yet, despite its significant size, the city faces economic challenges comparable to those of industrial-urban areas (Pouleur and Vanzande, 2017).

The trajectory effect as a factor of inequality between cities of comparable size can also be observed at higher levels of the urban hierarchy. This is the case for Glasgow, a city with a significant industrial past whose socio-economic structures have resulted in a competitive disadvantage compared to Edinburgh, a Scottish metropolis with more diversified functions (Béal and Rousseau, 2008; Leydier, 2005). This example seems to demonstrate that socio-economic structures inherited from industrial trajectories can hinder economic development (Pouleur and Vanzande, 2017).

Thus, the categorical distinction between industrial-urban areas and major regional cities tends to underestimate the existence of hybrid categories. Developing an urbanity gradient

³³ Charleroi and Ludwigshafen emerged in history as fortified towns in border regions, which industrialization helped develop throughout the 19th century. These cities experienced exceptionally high growth rates between 1840 and 1900, with Ludwigshafen growing by +981% and Charleroi by +429%

makes it possible to encompass the wide diversity of observable situations. In our research, this gradient helps distinguish other categories of urban spaces. This is the case for Longwy and Thionville, two medium-sized cities that predate the Industrial Revolution and are located at the heart of a steel and mining basin. These cities exhibit higher urbanity indices than the adjacent industrial-urban areas, which developed from small village cores

Variable selection : contributions, limitations, and perspectives

The contemporary metropolis has become the benchmark for defining "the city" and embodies "the very incarnation of urbanity" (Anaya, 2017). However, an urbanity indicator constructed from variables based on employment and higher education graduates may only serve to favor the largest cities while discrediting all others (Anaya, 2017). Nevertheless, these variables have made it possible to represent the evolution of the capitalist order that has dominated different historical periods (Boltanski and Chiapello, 2011). First, industrial capitalism, characterized by mineral extraction and the need for a working-class labor force; and later, contemporary and globalized capitalism, which exploits knowledge and capital concentrated in the largest cities (Sassen, 2004). Consequently, the analysis has been limited to a representation of major trends.

The chosen timeframe³⁴ reflects the restructuring of settlement systems and spatial organization under the influence of two major innovation cycles that have shaped European urban history from the 19th century to the present. While this temporal division is relatively robust, it has the drawback of smoothing out numerous variations over time, such as those related to wars, economic crises, and rapid accelerations in urban growth. Despite it, this temporal division has highlighted territorial trajectories that can enrich the specific typology of industrial-urban spaces compared to cities that predate the Industrial Revolution.

The difficulty in acquiring comprehensive economic data from 1840 to 1970 has led to the use of partial industrial data, which serve more as an indication than a basis for in-depth analysis. This challenge underscores the role of demography as the most robust variable for long-term analyses (Turok and Mykhnenko, 2007). However, the demographic and socio-economic data used in this study should systematically be combined with the spatial configuration of each location, defined as the third component of urbanity and a key focus of landscape-based approaches (Lévy and Lussault, 2003). Integrating these three components—demography, socio-economic factors, and spatial configuration—would strengthen the typology of industrial-urban spaces, offering a more comprehensive understanding of their development and characteristics.

Finally, studying the trajectory of industrial-urban spaces within the Greater Region holds significant potential for future research. The demographic renewal observed in areas near Luxembourg reflects a new form of dependency. Within a renewed spatial division of labor at the local scale, industrial-urban spaces now serve as a labor reservoir for the interests of a small European metropolis embedded in international financial networks. An analysis using updated data could examine, in light of contemporary socio-economic dynamics, the impact of the

³⁴ 1840 to 2011

presential economy on the evolution of urbanity levels—levels that remain tied to places still marked by socio-economic structures inherited from a heavy industrial past (Diop and Lamour, 2014).

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