Planning for agglomeration economies in a polycentric region:

Envisioning an efficient metropolitan core area in Flanders

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Abstract

To some degree, metropolitan regions owe their existence to the ability to valorize agglomeration economies. The general perception is that agglomeration economies increase with city size, which is why economists tend to propagate urbanization, in this case in the form of metropolization. Contrarily, spatial planners traditionally emphasize the negative consequences of urban growth in terms of liveability, environmental quality, and congestion. Polycentric development models have been proposed as a specific form of metropolization that allow for both agglomeration economies and higher levels of liveability and sustainability. This paper addresses the challenge of how such polycentric development can be achieved in planning practice. We introduce 'agglomeration potential maps' that visualize potential locations in a polycentric metropolitan area where positive agglomeration externalities can be optimized. These maps are utilized in the process of developing a new spatial vision for Flanders' polycentric 'metropolitan core area', commonly known as the Flemish Diamond. The spatial vision aspires to determine where predicted future population growth in the metropolitan core area could best be located, while both optimizing positive agglomeration externalities and maintaining its small-scale morphological character. Based on a literature review of optimum urban-size thresholds and our agglomeration potential maps, we document how such maps contributed to developing this spatial vision for the Flemish metropolitan core area.

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1. Introduction

In contrast to other macro regions where large metropolitan cities are the dominant form of urbanization, the West-European urban system is characterized by the presence of many comparatively small and medium-sized cities (Dijkstra et al., 2013). Transport costs played an important role in these cities' gestation prior to ubiquitous motorization. However, with the reduced contemporary relevance of such transport costs, these small and medium-sized cities have increasingly come to share hinterlands with their neighbours. Consequently, more than half of the European urban population lives in 'polycentric metropolitan areas' (EMI, 2012). Polycentric metropolitan areas are defined as sets of historically distinct, administratively and politically independent cities, located in close proximity to and well-connected through infrastructure (Kloosterman and Lambregts, 2001), and which have the potential for further integration. This process of functional integration is known as 'metropolization' (Meijers et al., 2014; Van Meeteren et al., 2016).

Economists, with their primary focus on generating economic growth, generally offer the policy recommendation to foster further urban growth and accommodate the rise of large megacities, for example, by lifting growth-restricting planning regulations (Alonso, 1970, 1971; Mera, 1973; see also Glaeser et al., 2016). Contrarily, spatial planners traditionally focus on the negative consequences of urban growth, and one of their recommendations throughout the last century has been to advance polycentric urban development models, starting with Howard's 'slumless and smokeless' Garden City (1902), principles such as 'concentrated deconcentration' (Friedmann, 1959; Rodwin, 1961), and the more recent focus on city networks. The confrontation between these two opposite viewpoints invokes debate on optimal city size: where negative and positive externalities are balanced (Alonso, 1971). The potential of stimulating metropolization to achieve a more optimal city size is often highlighted in the literature, invoking notions such as 'complementarity', 'functional division of labour' (Hall and Pain, 2006), 'borrowed size' (Meijers and Burger, 2017), 'city network externalities' (Capello, 2000) or 'urban networks' (Glaeser et al., 2016). Moreover, polycentric systems of small and medium-sized cities can allegedly support the positive externalities of large metropolitan regions without the drawbacks (Meijers and Burger, 2010).

Nevertheless, small and medium-sized cities in polycentric metropolitan areas generally find it difficult to translate their substantial joint critical mass into a high level of positive agglomeration externalities comparable to that of large unitary cities (Meijers, 2008a; Meijers and Burger, 2010; Burger et al., 2014b). While European spatial planners often cherish this positive side of small and medium-sized cities (such as lower housing costs, accessibility of green space, strong territorial identities, and feelings of belonging), the fear of not being able to withstand competition from large metropolises in the long run because of a lack of agglomeration economies leads to a conundrum for planners (Schmitt et al., 2015).

In order to fully reap the benefits of metropolization, governments of polycentric regions require solid strategic planning. In the current paper, we assess the extent to which introducing techniques and theories of spatial analysis in regional planning can contribute to a better substantiated and supported vision for the future spatial development of the polycentric urban region. Planning is never solely a technical affair of implementing the alleged optimal solution to a policy trade-off, in this case between liveability and economic growth. As planning processes are characterized by gradual goal displacement and therefore are doomed to fail in their stated objectives (Saey, 2002), spatial analysis has to be embedded in a wider governance process where aims and goals can be assessed dynamically and parameters adjusted accordingly.

This paper documents the insertion of spatial analysis in a deliberative planning process about the 'Metropolitan Core Area' (MCA), in Flanders, Belgium. The MCA has been stressed as a central area of spatial development of the wider Flemish region (Flemish Government, 2012), although its precise role in the planning process is yet to fully emerge (Flemish Government, 2016). To operationalize the MCA in planning governance, we set up a process that employs both conceptual and empirical knowledge on processes of metropolization and expert-stakeholder knowledge. Geographical analysis is introduced in the planning deliberation, and used to confront prior policy intentions of planners and other policy stakeholders (Thomas, 2016, p. 10). This paper explores the extent to which this method can help operationalize the concepts of positive urban agglomeration externalities and liveability targets in a growing urban region.

We continue by reviewing the literature how to define an optimal polycentric metropolitan area given environmental constraints. After introducing the particularities of the Flanders case in section three, section four develops a geographical analytical tool that visualizes the current contribution of a range of urban locations to agglomeration economies in the Flanders MCA. Thereafter, in section five, we assess how conceptual and empirical evidence developed in the context of a policy-supporting research assignment can nourish a visioning workshop. We gauge the usefulness of spatial analysis in relation to the visioning workshop by the extent to which it allows translation (a) from an exploratory exercise to a decision-supportive vision, (b) from an intuitive-qualitative approach to a formal-quantitative process, and (c) from a high degree of complexity to a relatively simple expression of proposed policy guidelines[1]. We attempt to steer the planning process by providing new substantive insights into a deliberative process. In the last part of the paper, we summarize the resulting spatial vision for the Flemish MCA by means of three corresponding schematic maps, which is not the official spatial vision as adopted by the Flemish government but should be considered the present authors' input to this decision-making process. We will conclude with a reflection on the transferability of the method applied.

2. Optimum city size and sustainable growth

2.1 Theoretical conceptions

The quest for the optimally sized city has long captured researchers' imagination. Yet, the question always is 'optimal for whom?' Because some people and firms flourish in small cities and others in large, there is no single answer, making optimum city size assessments subjective and dependent on values attached to specific benefits and costs (Richardson, 1972). Batty (2008) states that different city sizes are associated with a wide range of advantages and disadvantages, and therefore concludes that the question of optimum city size has always been open. Interestingly, the ideal size of a city is usually formulated in terms of liveability and environmental quality (Eaton, 2002). It is implicitly assumed that there is an upper size limit beyond which the quality of life in a city is no longer guaranteed. This is apparent in 1960s' analyses of suburbanization, where a cultural propensity of rational human beings to live in spacious new houses was often invoked as a microeconomic explanation for the sprawling metropolis (e.g. Alonso, 1964). This dated assumption (Wyly, 1999) is in tension with the macro urban-economic perspective where the motto seems to be 'the more, the merrier': when more individuals can interact with each other in the course of a working day, there will be more potential for a division of labour, for specialization and for matching supply and demand (Alonso, 1971; Mera, 1973; David et al., 2013). This interaction potential is higher in denser urban environments compared with simply more extended urban areas, even though their population size may be similar (Törnqvist, 1977; Glaeser et al., 2016).

It is commonly assumed in the spatial economics literature that market forces, guided by the 'virtues' of near universal car ownership and unconstrained land markets, automatically lead to an optimal city size. Where negative externalities (congestion, pollution, and nuisance) exceed positive effects (economies of agglomeration), more complex, polycentric, metropolitan constellations emerge (Richardson, 1972; Anas et al., 1998; Fujita et al., 1999; Glaeser et al., 2001). At best, policies can shift this equilibrium a little. When polycentric urban constellations are adequately connected internally, preferably by means of a transport and communication system that is fast and congestion free, such a system is expected to provide a perfect breeding ground for a thriving economy.

At first sight, there seems to be evidence for the hypothesis that larger agglomerations foster stronger economies. But at least in Western Europe, the relationship is less straightforward. David et al. (2013) tested the city size hypothesis on EU cities having over 200,000 inhabitants and concluded that since 1960, no direct link can be established between the size of the city and its growth rate or economic performance. This finding can be interpreted in different ways. At the regional level connectivity levels in Western Europe have possibly increased so much that the individual city no longer provides a useful scale by which to measure economic performance. The systematic increase of commuting distances, which could be observed at least until the beginning of the

21st century, points in that direction.

This reservation chimes with a classic argument in town planning. In Garden Cities of Tomorrow (1902), Ebenezer Howard described his ideal city as consisting of no more than 32,000 inhabitants, on the condition that this intended garden city would be part of a polycentric network. This network, however, would serve economic interaction mainly through transport of goods, while inhabitants would be employed in their town of residence and daily commuting between towns would be negligible (Hall, 1988). Alonso (1970) stresses the relevance of distinguishing between new towns that are supposed to be relatively autarchic and new towns that could function as a new node within an existing agglomeration. While he sees potential in the latter, he doubts the economic viability of the former, which only makes the question of the criteria for a (new) town to be considered part of a larger agglomeration more pertinent. Nevertheless, new town and polycentric ideas resonate in several planning concepts of later date, such as in Clarence Stein's 'Regional City' concept (Parsons, 1998; Meijers, 2008b). Haughton and Hunter (1994) envision about 100,000 to 250,000 inhabitants, not because they think such a city would provide the most comfortable place to live, but rather because they believe that smaller cities would, by definition, be deficient in providing a breeding ground for a thriving economy. When we confront this statement with the size of most city regions in the world economy, however, it is apparent that there are size-related agglomeration effects that suggest optima significantly larger than 250,000 inhabitants. Camagni et al. (2012), for instance, observe several high-level urban functions that exhibit thresholds of between one and two million inhabitants.

However, determining whether two settlements are part of the same agglomeration at a given time is no straightforward exercise. Agglomeration economies have a variable geometry (Lang and Knox, 2009): some types of externalities are associated with the density of the central city, where others are associated with the scale of the functional labour market and yet other effects may cover an even larger area (see Van Meeteren et al., 2016b). Parr (2005) advocates demarcating the agglomeration with the criterion of reasonable self-containment, where the majority of agglomeration effects are within rather than beyond the area. If that is the case, the interplay of the 'daily urban system', which is often empirically based on commuting distances (e.g. Berry 1970) but comprises all daily routine interactions with the larger (non-daily) metropolitan and central place systems, becomes important in defining the MCA (Van Meeteren, 2016).

2.2 Interaction: between agglomeration and polycentricity

At present in Belgium and elsewhere, most urbanization is essentially 'sub/urbanization', where the in-between space gradually acquires centrality: the difference between city and suburb blurs (Ghent Urban Studies Team, 1999; Phelps et al., 2006; Keil, 2013). This blurring complicates the city demarcation problem; yet properly demarcating analytical nodes is paramount when comparing cities in supra-regional

networks. Studying urban areas in global economic networks commonly assumes that contributing metropolitan regions can be regarded as nodal regions (Van Meeteren et al., 2016b). However, this nodalization procedure abstracts from the specific settlement geography by assuming that each nodal unit has a comparable internal structure. Nodalization largely neglects the friction of distance (Haig, 1926) within the sub-areas of the nodal region. This might to some extent be warranted in the economic network of the United States where many inter-city movements occur via well-developed domestic air travel, which is relatively less sensitive to distance decay. This assumption holds less in Europe because cities are more closely spaced and inter-city travel occurs via road and rail (Clark and Kuijpers-Linde, 1994; Van Meeteren et al., 2016c). Here, regarding polycentric urban regions (Parr, 2008) as consisting of imbricated daily urban systems is a more appropriate assumption.

In polycentric regions, different cities are expected to 'borrow size' from one another (Alonso, 1973; Meijers et al., 2016), making the sum of settlements more than its constituent parts. However, assuming a polycentric urban system instead of a single city severely complicates the notion of an optimal metropolitan size, and hence makes the analysis of how borrowing size can help meet the assumed optimal thresholds more difficult. The contribution to critical mass and positive agglomeration externalities of a person living in an urban area is already substantially higher than the contribution of a person in a city's functional hinterland (Burger et al., 2015). Moreover, more compact sub-centres tend to be more efficient, so perhaps population thresholds for optimal metropolitan size should be higher in polycentric metropolitan regions (cf. Cervero, 2001).

The type and reach of agglomeration economies also varies, meaning that the different urban nodes become imbricated to a different degree for each type of agglomeration effect (Van Meeteren et al., 2016b). As the commuting zone expands when education levels rise, even the daily urban system in itself loses its status as a category with a fixed upper spatial limit comparable across regions (Burger et al., 2014a). Consequently, some aspects of agglomeration economies tend to be more easily borrowed than others, based on the different ways that settlements interact (Meijers and Burger, 2017).

All these complexities point to the necessity of careful spatial demarcation of one's study region, coupled with due recognition that determining 'the' optimal metropolitan region is impossible and its boundaries perforce contentious. Nevertheless, we maintain the general rule that agglomeration economies by definition benefit from mass, which may lead to the perhaps naive assumption that bigger is necessarily better. Of course, the economics literature is also aware of the disadvantages of unlimited growth of urban agglomerations, which are usually classified under the term 'congestion' (Alonso, 1971). In this context, congestion does not only point to a quasi-permanent traffic jam, but refers to all possible problems stemming from an extremely high concentration of activities. In many cases, these problems have no

direct net negative economic impact. For example, for many companies, while the cost of traffic jams will not outweigh the benefits associated with an urban office location, congestion may adversely influence the quality of life and the local environment, particularly for those who have little choice about where to live (Ellegård et al., 1977). Although more difficult, quality-of-life threats can also be expressed in monetary terms and are increasingly put forward as arguments against new traffic-generating construction projects and infrastructural works (Verbeek and Boelens, 2016).

The concept of 'interaction potential' can analytically provide a more refined assessment of this trade-off. An agglomeration that is both internally and externally well-connected will represent more potential for interaction compared with a city that functions in a relatively autarchic way (Alonso, 1971). This notion applies to different scales. In theory, well-connected smaller towns could form a larger functional polycentric region, although in practice this potential is not always realized (Meijers, 2008a; Burger et al., 2015). Processes of metropolization, where regional urban networks become more interdependent and interaction potential is realized, require policy and guidance (Meijers et al., 2014). Nevertheless, interaction potential with other urban agglomerations or economically strong regions can be more important than the size of the city itself when gauging potential future urbanization (Friedmann, 1968; Dijkstra et al., 2013), which relays confidence about the broad agreement in the economic geography literature that the cities that are (a) largest, and (b) best connected (to other cities, to the hinterland, but also internally), are believed to be the most efficient.

2.3 Conclusions regarding optimum city size

Although the above-mentioned considerations provide plenty of ambiguity about what the optimal metropolitan size ought to be in the Flemish context, only an informed choice of a threshold can provide the basis for a spatial development perspective. As noted, Camagni et al. (2012) find minimum thresholds of 1–2 million inhabitants for high-level metropolitan functions. This number is corroborated by McCann and Acs (2011), who conclude that an urban region must have about 1.5–2 million inhabitants to be sufficiently big to function effectively as a node in global urban networks. In the analysis by McCann and Acs, the smallest cities that are still in the spotlight are Geneva (0.45 million inhabitants), Auckland (1.2 million), Lyon (1.6 million), Dublin (1.6 million), Oslo (1.8 million) and Helsinki (1.8 million). In what follows, we stick to these reference numbers and subscribe to the hypothesis that 'bigger is possibly better' as long as the 'bigger' would not entail significant detriments to environmental quality and liveability. As mentioned, thresholds may be somewhat higher with regard to relatively scattered polycentric metropolitan regions.

Although sustainability considerations suggest that an upper limit should also be observed when regarding the desirable size of metropolitan regions, sustainability may be more a question of spatial organization, pursuing the avoidance of all kinds of congestion effects

in relation to traffic, air quality, living space, and access to green and open space. On the level of the latter two objectives, the answer is largely contained in the decentralized nature of polycentric morphologies. With regard to these congestion effects, a vision of urbanization that aims for less dependency on private cars and road transport may provide the best possible answer. In the wider literature on sustainable transport, this position is reflected by a number of planning principles on nodal development. Particular interpretations of the concept of transit-oriented development (TOD) (Newman and Kenworthy, 1996; Van der Bijl and Van Oort, 2014) point in this direction, as does the principle of compact development as established in the current Green Paper and White Paper of the Flemish Government (2012, 2016).

3. Planning case: Flanders' metropolitan core area

The Flanders region (the Dutch-speaking, northern part of Belgium) is an archetypal example of a polycentric metropolitan area that has been compared with the Randstad (The Netherlands) and the Rhine-Ruhr areas (Germany) (Dieleman and Faludi, 1998; Albrechts, 1998). The regional government ponders a 'metropolis Flanders', which ought to be large and efficient enough to position itself successfully in the urban economic network of the north-western European delta. According to the Flemish government, the heart of this urban agglomeration is the 'Metropolitan Core Area' (MCA). This MCA comprises roughly the functional space of the quadrangle Brussels–Leuven–Antwerp–Ghent and is intended as a more politically neutral term[2] for what is commonly known as the 'Flemish Diamond' (Albrechts and Lievois, 2004) (Figs. 1, 2, and 3).
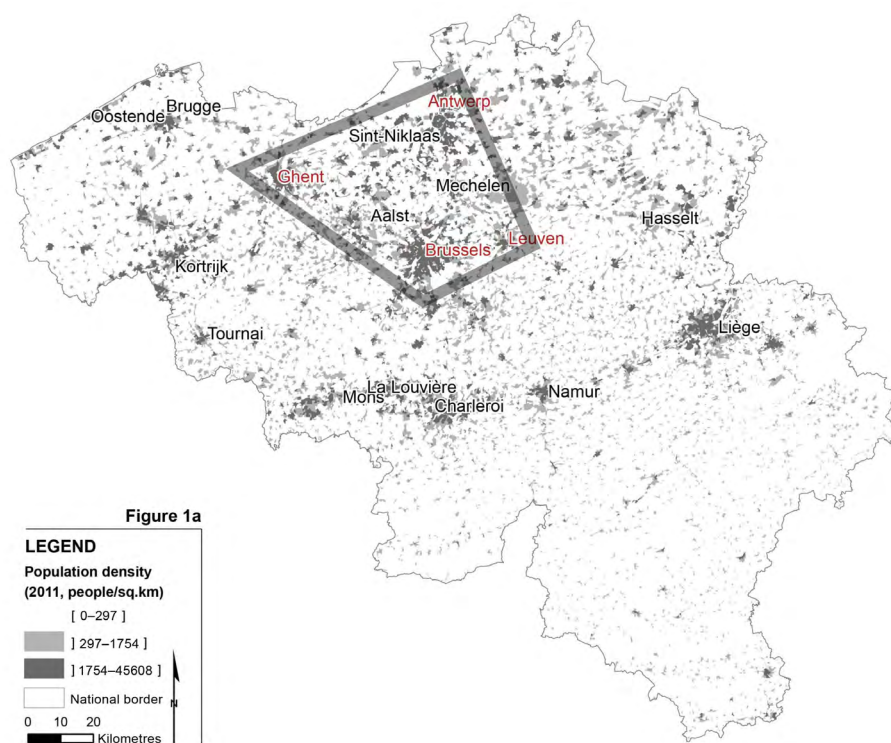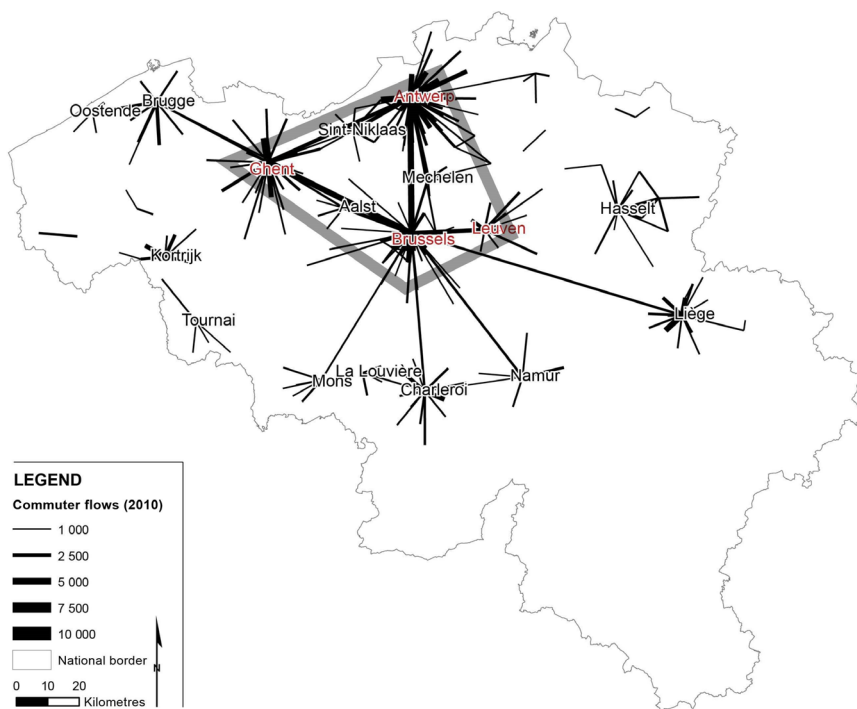

Figure 1: Flemish Diamond in relation to the distribution of the Belgian population.

Figure 2: *Flemish Diamond in relation to the major migration flows in Belgium.*
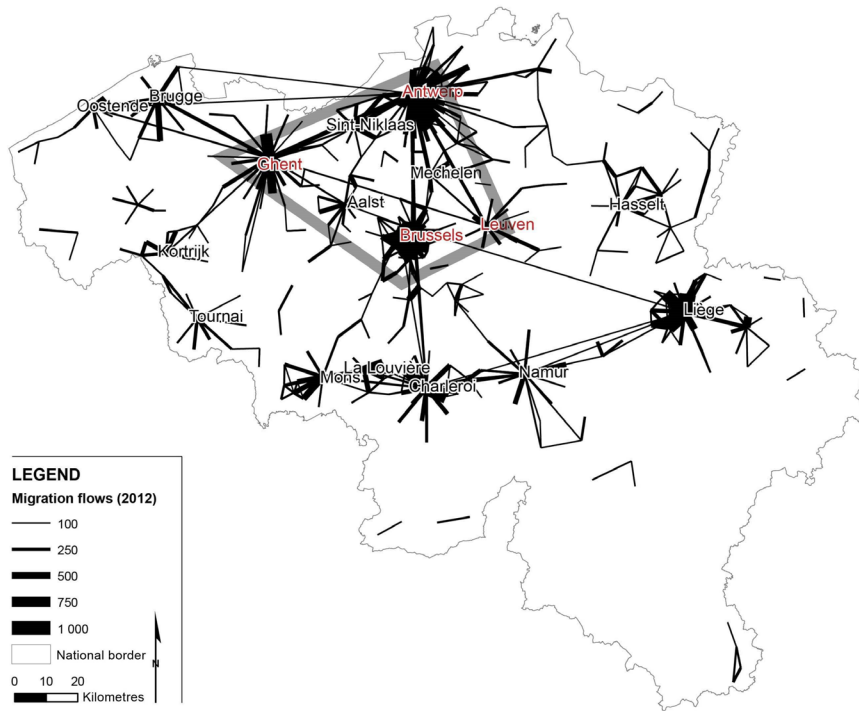
Figure 3: *Flemish Diamond in relation to the major commuter flows in Belgium.*

The densely populated MCA, comprising more than 4 million inhabitants at over 800 inhabitants per square kilometre, shows important variations in terms of density. According to Van Hecke's (1998) definition, it contains six urban agglomerations, namely those of Brussels (1,627,000 inhabitants), Antwerp (776,000), Ghent (303,000), Leuven (123,000), Mechelen (101,000) and Sint-Niklaas (77,000), that are interspersed by a peri-urban area characterized by a fabric of smaller towns, villages, and ubiquitous urban sprawl. The MCA is well-embedded in the European context in terms of accessibility, but experiences a variety of pressures. For example, a large portion of

the predicted population growth of Flanders and Brussels is expected to occur in this area (Willems and Lodewijckx, 2011), and the region suffers heavily from road congestion, air pollution, and landscape fragmentation due to Flanders' sprawled urban morphology. Apart from the considerable adverse effects of air pollution on general health (Arden Pope III et al., 2009), in the Belgian context, large cities are also known for very compressed, often substandard, housing, the virtual absence of greenery and open space, and pervasive noise problems (Vanneste et al., 2008), which contributed to suburbanization in the past.

The demarcation of the MCA in the current paper requires additional explanation. Boussauw et al. (2013) and Van Meeteren et al. (2016a) explain how the Belgian metropolitan node spreads out functionally across three administrative regions (Flanders, Brussels Capital Region and Wallonia), with the Dutch–French language border being a strong barrier within some sectors (e.g. regarding a range of public services), but negligible in many others (e.g. international business; see also Jones et al., 2016). Because the study area covers both the administrative regions of Flanders (partly) and Brussels, we in fact discuss 'a MCA in northern Belgium'. We are aware that other, equally valid regionalizations of MCAs in Belgium are possible when focusing on other parameters and scales (Van Meeteren et al., 2016a). Nevertheless, in current visions developed by the Flemish Government, the MCA is an internally and externally well-connected urban network that is envisaged to further integrate in the future. As spatial planning in Belgium has been a regionalized function since 1980, planning policies in the three Belgian regions of Flanders, Brussels (the capital region) and Wallonia have developed independently[3]. There are virtually no planning tools that fall under federal competence, with the notable exception of national railway policy.

This current research is part of the ongoing elaboration of a new comprehensive spatial plan for Flanders, for which the guidelines were set out in both the Green Paper and the White Paper on Spatial Policy in Flanders (Flemish Government, 2012, 2016; cf. Boussauw and Boelens, 2015). Therefore, the choice to centre on Flanders and Brussels instead of a larger area is in part driven by the administrative structure of Belgium and the priorities of the institution funding this research[4], albeit with an empirical basis of a certain degree of self-containment.

Although changes of government together with the complex institutional context have delayed the promulgation of this plan, the White Paper provides rather clear guidance on how 'sustainability' and 'liveability' are conceived within Flanders. In the White Paper, liveability relates to the negative effects resulting from urbanization, including traffic nuisance and health risks. So-called 'space-efficient' mobility, organized around collective transport nodes and concentrations of amenities, is explicitly presented as an intended development aimed at increasing levels of liveability (p. 96). Preservation of open space, by concentrating additional buildings, is mentioned as well (p. 101). Sustainability, in turn, is associated with multimodality (p. 53) and, again, with efficient use of space. Although this approach seems to be somewhat restrictive, it allows us to focus and to propose concrete solutions.

The sustainable growth angle is supported through delineating the (potential) MCA from a non-automobile-oriented perspective. Traditional spatial economic theories view transport as a medium that can be represented in models as a cost, but rarely make distinctions between the various transport modes. However, in present day Flanders, it is now difficult to defend a car-oriented vision of urbanization, given omnipresent congestion (Dewulf et al., 2015), the high environmental and social costs related to road traffic, the lack of space, and the fading public support for the building of additional road infrastructure (Boussauw and Boelens, 2015). The exploratory phase of this research scrutinized these assumptions, and road-based 'agglomeration potential maps' were examined alongside rail-based accessibility. Potential accessibility via road, however, reinforces a quasi-monocentric accessibility potential, which differs fundamentally from the polycentric development perspective outlined in the Flemish policy documents. In conjunction with the above considerations around congestion and public support, and the White and Green Paper-based conceptions of sustainability and liveability, the road-based maps were only of value to the visioning workshop as a deterrent for a 'non-intervention' scenario. Consequently, in the cartographic analyses and the subsequent visioning workshop, the traditional concept of road accessibility has been replaced by accessibility by rail transit. As a corollary, a metropolitan area is visualized that is well-situated around the main stations and nodes of high-quality public transport, scrupulously following the applicable Green and White Papers' guidelines.

4.   Spatial analysis: visualizing agglomeration potential

4.1 Assumptions

When confronting the ambiguous notions of optimum size with the policy goals, the first thing to note is that the current MCA already (easily) meets the threshold requirement of 1.5–2 million inhabitants. This is especially the case, since the functional metropolitan region is even larger than our study area, as it reaches far into the neighbouring region of Wallonia (Van Meeteren et al., 2016a), and stimulation of scalar growth of the total metropolitan region ought not to be the primary policy objective. Rather, directing expected growth in a more sustainable direction (Zhao and Pendlebury, 2014), without the system losing its current performance seems a more pertinent aim. National and regional forecasts signal significant future increases in population in the centre of the country. According to the Belgian Federal Planning Bureau, the population of Flanders and Brussels together will increase by more than half a million people in the period 2014–2030, which corresponds to an additional requirement of more than 200,000 dwellings (Willems and Lodewijckx, 2011; Federal Planning Bureau, 2014). Simultaneously, there is consensus on the need to organize new developments in a more compact and less car-dependent manner, in order to break the transport/land-use feedback cycle (Bertolini, 2012). Particularly as the expected congestion effects of further monocentric metropolization would

manifest themselves in the form of less floor space per dwelling, more limited access to outdoor space, increased exposure to air pollution and traffic noise, and accessibility problems for road traffic (Burton, 2000), the choice of a TOD-based polycentric regional development model is vindicated and in line with the definition of liveability by the White Paper. Moreover, the existing, dense network of 'traditional' railways in Belgium offers a unique opportunity for compaction. Consequently, the planning challenge reads as follows: How can we ensure that additional jobs and homes engraft on a sustainable and resilient transport system, so that it reinforces the total critical mass of the labour market, while thickening it in the most appropriate locations?

4.2 Tool: the 'agglomeration potential map'[5]

To execute an evidence-based planning exercise (Faludi and Waterhout, 2006), we designed a method for visualizing the accessibility of critical population masses. In the cartographic analyses and the subsequent visioning workshop, the traditional concept of road accessibility has been replaced by rail transit accessibility. As a corollary, a metropolitan area is visualized that is well-located around the main stations and nodes of high-quality public transport, scrupulously following the applicable Green and White Papers' guidelines. The main guiding principles of the analytical exercise developed are: (1) ensuring the internal connectivity of the region through rail transport (train, metro, light rail, tram), and (2) ensuring the accessibility of the four cities demarcating the MCA (namely Brussels, Antwerp, Ghent, and Leuven).

Our approach is based on traditional population-based accessibility maps. In their simplest incarnations, traditional accessibility maps use one central point (the destination), after which concentric zones are delineated within a certain travel time from that point, taking into account the underlying transport network (which could be, e.g. road based or rail based). More advanced incarnations use a set of central points. The boundary of each concentric zone is an isochrone, which is a line on which each point is located at the same travel time (e.g. half an hour) from a central point. Isochrones are generally calculated by means of a shortest path algorithm (Dijkstra algorithm), where an estimated average speed is assigned to the segments of the underlying transport network. This calculation method disregards, and is therefore sensitive to, the existence of all kinds of delaying effects such as congestion and timetables of transit companies that are usually not incorporated in the maps of, for example, the railway network.

In the present study, we are less interested in the precise location of the isochrones as experienced by present-day commuters than in looking for the area within which a certain critical mass of residents (e.g. 1 million) is located, that is, residents who are as close as possible to the centre or centres of the area measured through cumulative travel time. We recognize that taking into account population only (thus not, e.g., jobs) provides a partial perspective. However, because we intend to feed a planning exercise, a certain degree of complexity reduction is required. Moreover, the designation of suitable locations for building

additional housing, that is the allocation of additional population, is an explicit objective of the exercise, in line with the Flemish Government's planning documents.

To produce the intended map, it is necessary to select a central point and a transport network. As the MCA is a fairly diffuse spatial concept for which the meaning and scope have not yet fully crystallized, how to make such methodological decisions is not self-evident. The cities of Ghent, Antwerp, Leuven, and Brussels have been considered the anchoring nodes of the MCA since the Flemish Diamond was introduced (Albrechts, 1998) and we have retained them in this study.

Although the four anchor cities selected differ considerably in terms of size and economic importance, we will approach them as equivalent nodes of the MCA. This is justified by the framework of the White Paper, which attempts to graft urbanization in Flanders as much as possible onto a network of existing urban agglomerations. Because the Brussels Capital Region is administratively independent from the Flemish Region, and its administrative frontier coincides with a language barrier, we focus first and foremost on the other centrally located cities and their hinterlands. By selecting the four cities mentioned as boundary elements of the MCA, we include the White Paper's rejection of monocentric development attached to the Brussels or Brussels–Mechelen urban agglomeration. Within these four MCA anchor points, each main train station is selected as a particular focal point for the exercise of spatial analysis. This choice is justified by the planning goal that the MCA must be supported by an infrastructure of high-quality public transport.

To analyse the use of a transport network, we utilize a computer model of the road and rail (including metro and tram) networks (NavStreets and Open Street Map data), as well as the related transit timetables (General Transit Feed Specification; GTFS). Bus lines are excluded, given their volatile nature and less significant effects on spatial structure. Combining car and rail travel in a simplified multimodal network was contemplated, but without proper data about road congestion levels and other time-saving assets of train travel (Gripsrud and Hjorthol, 2012), the exercise was deemed irrelevant. Hence, we decided to focus on rail transport potential. Moreover, the maps are meant to serve a future-oriented development strategy, which will initially be oriented towards rail transit rather than motorways.

The rail network was analysed through two approaches: (i) the 'theoretical potential use' and (ii) the 'actual potential use' of the rail network. 'Theoretical potential use' refers to an estimate of the average speed of transit services, assuming that the entire railway network is operated in a uniform manner, and that on all available lines, trains are continuously departing. Average travel speed for (i) trains, (ii) metro and light rail, and (iii) trams is estimated at 80, 40, and 20 km/h, respectively. Feeder transport (the distance between the closest local station and the centroid of the census ward) is simulated at the speed of walking (5 km/h).

Actual potential use is based on existing timetables using open-source GTFS data, thus including actual frequencies and incorporating

waiting time at stopovers. As a corollary, the friction of distance is not operationalized by the respective average speeds that are assigned to the different transport modes, but rather is represented by the timetable itself. However, the results of a network analysis based on transit schedules can vary greatly depending on the chosen starting time. The transit schedule, which was probed with 10-minute intervals, performed on a standard Tuesday in May 2015, was therefore averaged out to account for time-dependent extremities.

These two approaches both measure potential use, because data on the thickness of the effective commuter flows were not included in the analysis. This is justified because the maps will be used to develop a long-term vision for the MCA and should be representative of the potential rather than the current functional relationships in the considered region.

All calculations are based on the centroids (gravity centres) of the census wards. These centroids represent the most detailed geographical scale for which population statistics are provided by Statistics Belgium. The central station locations are used as the starting points of the network analysis, and the centroids of the census wards as the endpoints. For each census ward, the sum of travel times (in minutes) from all four starting points to their endpoint was then assigned to the census ward in its entirety. Finally, to calculate the accessible population mass, the cumulative sum of the residents of the census wards was calculated, in ascending order of the cumulative sum of the travel times from the four anchor points. Mathematically, we could express the way the maps have been built as follows:

$$D_i = d_{iA} + d_{iB} + d_{iL} + d_{iG} \text{ subject to } i < i + 1 <-> D_i < D_{(i+1)}$$

$$\text{and} \quad P_t = \sum_{(i=1)}^{n} p_i \quad \text{as long as} \quad P_t \le t$$

in which:

$d_{iA,B,L,G}$ = rail travel time between the centroid of census ward i and the respective anchor points *A, B, L, G*

A, B, L, G = anchor points Antwerp, Brussels, Leuven, and Ghent

i = census ward label (in ascending order according to the value of *D*)

p_i = population of census ward *i*

t = threshold value employed when building the maps (t = 1.5 million, 2 million, 2.5 million, etc.)

Although merely utilizing four anchor points simplifies the analysis, the resulting zoning gives an adequate approximation of rail accessibility in the MCA. Strictly speaking, the delineated zones only include residences of that part of the population that has a good rail connection to the four stations, but in a broader sense, these zones can also be seen as a

search area for organizations, businesses, or households that demand an excellent overall accessibility to/from the four anchor points. A central position in this area guarantees a considerable amount of interaction potential with, for example, employees or employers, especially when this structure would indeed be strengthened in the future.

4.3 Resulting maps

Figs. 4 and 5 represent the spatial accessibility of the population from the four anchor points of the MCA. Through a continuous colour spectrum, both maps indicate how extensive is the population that lives closest to the four anchor points. The different colours indicate successive orders of magnitude of this critical mass, expressed in millions of inhabitants, in which the phase from dark to light red represents a mass of 2 million inhabitants. Orange, yellow, green, blue, and purple comprise consecutively larger, but less accessible population masses.
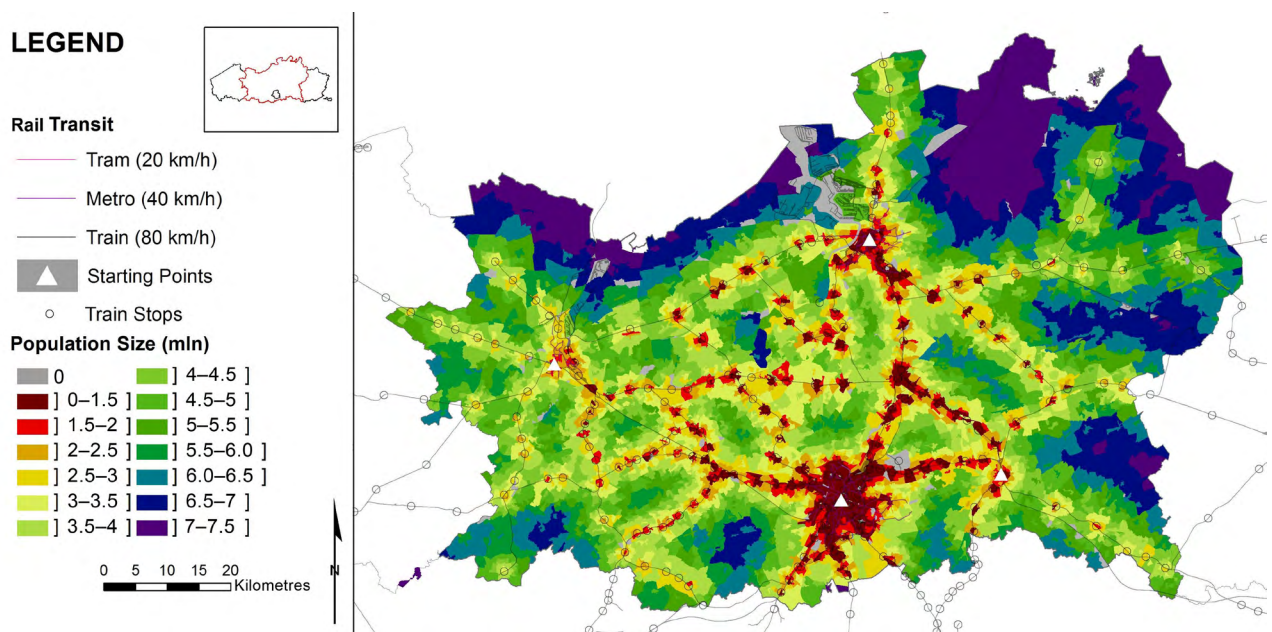

Fig. 4 shows the accessibility of the population based on rail transport, and more specifically the theoretical potential use. The distance between stations and dwellings, covered in our model by walking, emerges as an important accessibility constraint towards the intermediate areas where little or no railway infrastructure is built. As an immediate consequence, areas for critical population masses can be found in the vicinity of railway stations and stops[6]. These maps form a promising starting point as search locations for future compact and transit-oriented developments. Through concentrating new residential developments at well-connected railway stations or stops, the MCA could grow in a sustainable manner.

Fig. 5 is based on the actual potential use of rail transport. The differences between Figs. 4 and 5 illustrate how accessibility is influenced by something as seemingly ephemeral as a public transport schedule. For example, the surroundings of Mechelen, Leuven, and the airport are very well endowed, while the reverse is true for the south of the province of East Flanders (south of Ghent). The differences are indicative of how much service potential lies in the existing rail

Figure 4: Rail network-based agglomeration potential map: theoretical potential use.

infrastructure. Certain parts of the railway network show more potential to open up locations for additional compact development of housing or employment, compared with the current situation. It is important to note that a number of railway lines are subject to technical restrictions on capacity, for example, because they have only a single track, or have not been modernized and thus only permit reduced speeds. On such lines, service frequencies cannot be increased easily, not even if a clear demand existed. Therefore, realizing desired service potentials should primarily be seen as a strategy for the longer term or for the time when funding for upgrading these lines becomes available.

Figure 5: *Rail network-based agglomeration potential map: actual potential use.*
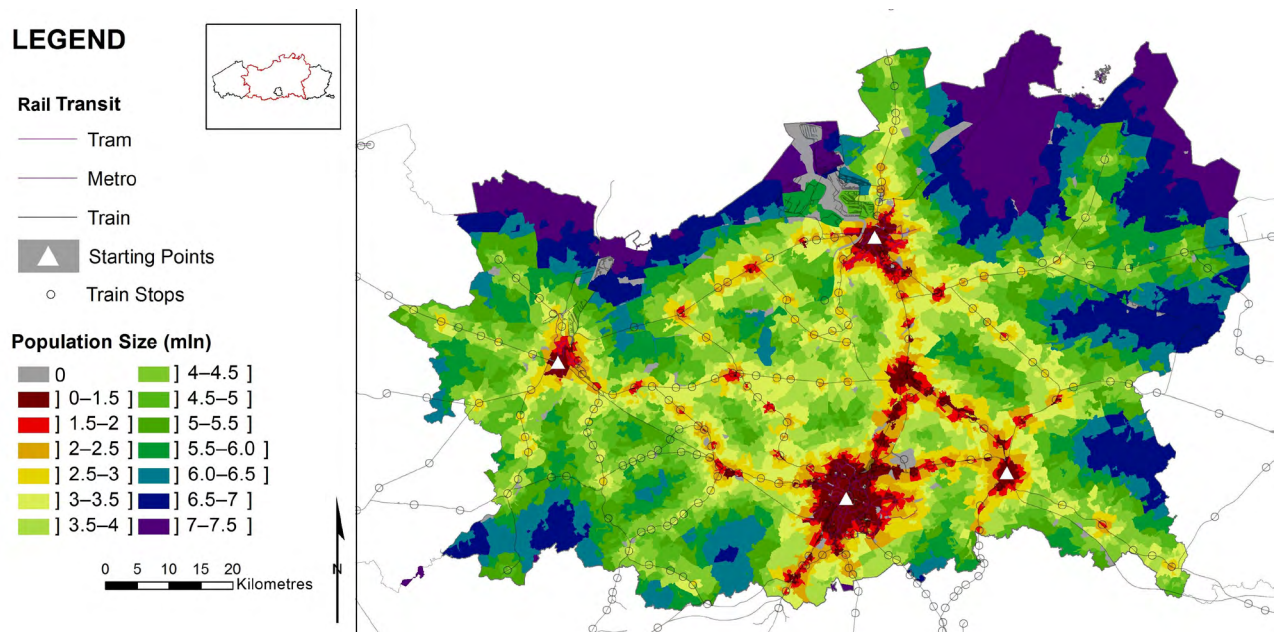
Nevertheless, the service potential provides an interesting indicator to adjudicate priorities in railway upgrading if a better-functioning MCA is the policy aim. Moreover, most rail infrastructure is managed by a single public company (Infrabel), making the implementation of a transit-oriented development scheme far easier than in the case of a greenfield development, a situation comparable to the 'Stedenbaan' project in the Netherlands (Spaans and Stead, 2016; Oliveira and Hersperger, 2018).

5. From maps to vision

5.1 Expert-stakeholder visioning workshop

The agglomeration potential maps offer insight into the potential functioning of residential, employment, and transport systems in the MCA. In the final stage of our study, covered in this section, the maps are utilized to aid in developing various scenarios for living, working, and the transport system in the MCA. An expert–stakeholder visioning workshop was organized in consultation with the commissioning department. The contours of the visioning workshop were defined quite tightly, based on the Green Paper on Spatial Policy (Flemish Government, 2012), and further focused through those outcomes of stages one and two that suggested the importance of a rail-based optimization of the MCA.

The purpose of the workshop was to develop an expert consensus-based vision on how to optimize the MCA in a sound manner, from economic, sustainability, and liveability perspectives. The desired outcome was a spatial vision that summarized the results of the discussion as far as possible. Expert stakeholders were not only selected based on their expertise in the various relevant sub-domains, such as spatial planning, mobility, housing, public transport, regional economics, and public administration, but also considering their capacity in representing the varying interests and positions of their employers. Nevertheless, during the workshops, positions represented by the participants converged considerably, revealing how closely aligned expert opinion is despite potentially divergent stakeholder interests.

The visioning workshop was held in mid-2015, and was supplied with a number of background maps, including reference layers and various visualizations of the actual built environment, the labour market, and the housing market. The agglomeration potential maps were presented as an additional planning support tool, representing the rail-based agglomeration potential of the Flemish MCA. Therefore, these new maps augmented the extensive knowledge base already present in the expert stakeholders involved. Representing a body of knowledge, the maps played a role as a focusing device, a mechanism that pivots a group of actors on solving a given planning problem constrained by specific guidelines (Rosenberg, 1969), i.e. the propositions about the future directions of the MCA as set out in the Green Paper (Flemish Government, 2012) and the first two stages of the research.

The debate was organized around three key domains that pertain to crucial dimensions of the spatial extent of metropolization: the labour market, the housing market, and the transport system. Each theme was introduced with a relevant albeit controversial example to elucidate the convergent and divergent opinions among the participants in the process.

The workshop commenced with opportunities and threats regarding spatial labour market integration in the MCA. In this discussion, the agglomeration potential maps yielded the insight that many areas in the Brussels fringe where job supply is growing, are not served at all by rail public transport, while other areas, particularly those located along the Antwerp–Brussels canal and possibly along the future northern light rail projects (Brabantnet, see also below), are, or could become, well-connected.

Subsequently, the discussion continued on the theme of housing supply. A number of regional housing markets with potential for additional compact development were highlighted, mainly existing towns that are centrally located in the MCA, with a fairly complete range of facilities and with good rail links to almost all central cities in the MCA but without a direct connection to the motorway network.

The transport issue was then discussed. Brabantnet was elaborated as an example. This is a future light rail network that will improve the connection of those areas north of Brussels that are currently underserved by public transport to the Brussels metropolitan area, a

situation underlined by the agglomeration potential maps. This will result in a more sustainable and efficient link between working and living in the region.

5.2 Outcomes for the Flanders MCA

A detailed report of the discussions is beyond the scope of this article (we refer to Van Meeteren et al. (2015) for further elaboration). However, the positions and elements of the vision from both work sessions were synthesized in three spatial structure schemes (Figs. 6, 7, and 8). Below, we highlight four main conclusions, which are also included in the legends of the structure schemes.

Figure 6: Spatial development perspective with regards to employment.
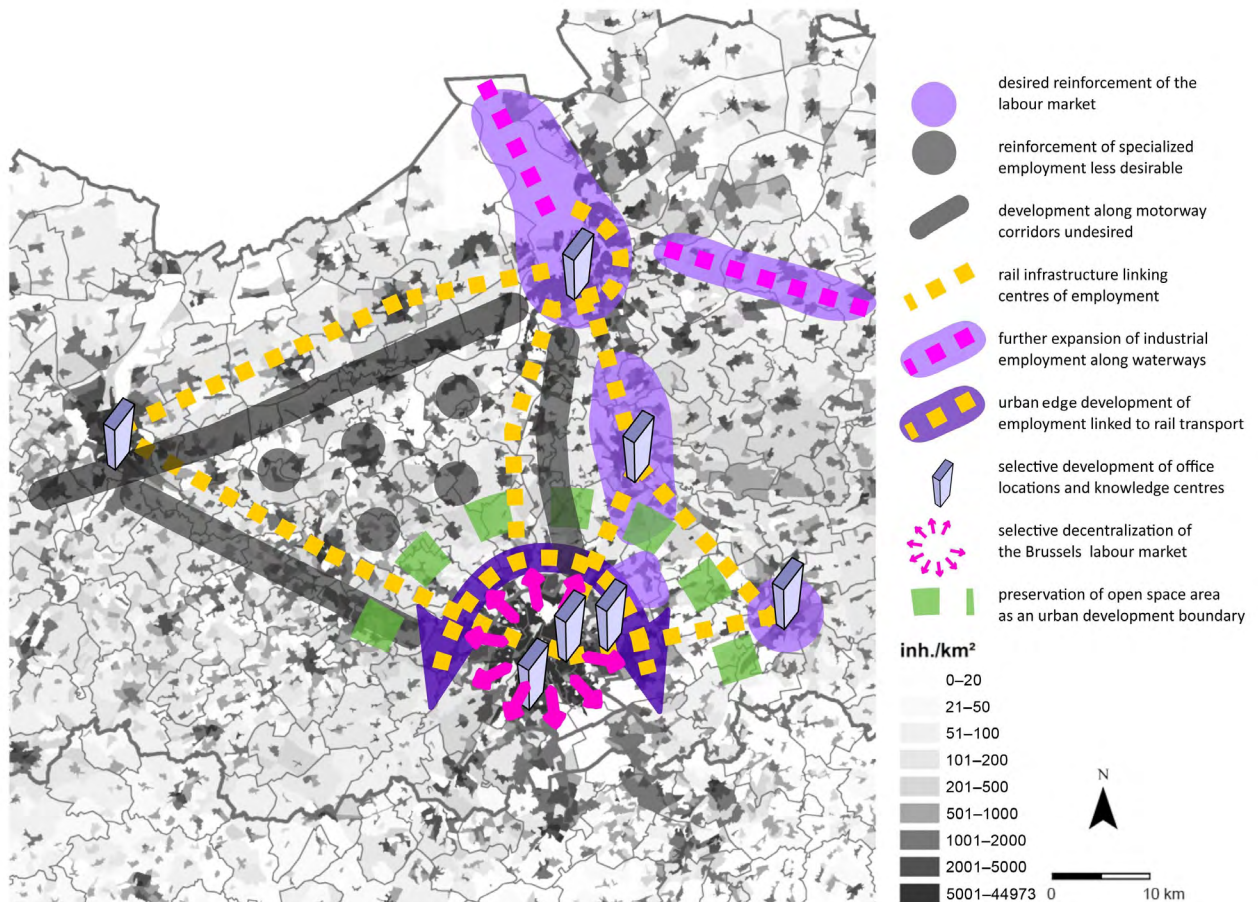
First, the importance of the Antwerp–Mechelen–Brussels axis as a regional housing market and economic development corridor cannot be emphasized enough. High-quality public transport will have to ensure both internal connectivity and external accessibility of this urbanizing area. To get such a transit-oriented system to work optimally, compact development is considered paramount. The main areas to be opened up to compact and transit-oriented development through densification, are the twentieth-century suburban belts of Brussels and Antwerp. The focus on the Antwerp–Brussels connection does not imply that the traditional Flemish Diamond region, and particularly the region around Ghent, is marginalized. The Ghent agglomeration is an important central place for the provinces of East Flanders and West Flanders. Moreover, Ghent is an important supplier of highly educated labour to

Brussels, and could remain so; the (network) relation then could even be intensified. However, the area in-between Ghent and Brussels is at this moment not yet a contiguous functional urban region. Fully extending the metropolitan core beyond the Antwerp–Brussels axis would likely require a large expansion of the Belgian economic base (Van Meeteren, 2016). Contrarily, the housing and labour markets of Leuven are, through their proximity, fully integrated with the core area.

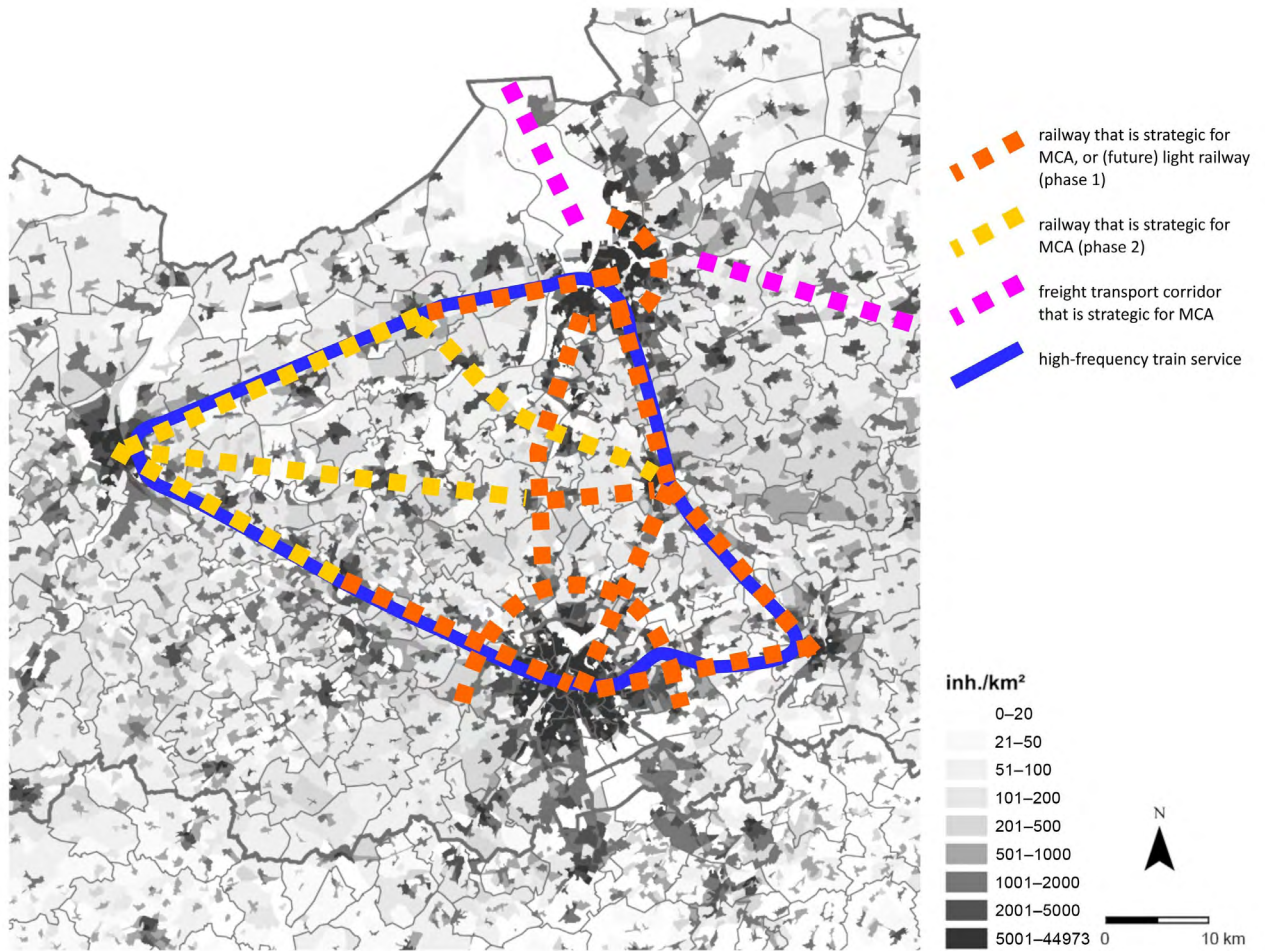*Figure 7: Spatial development perspective with regards to residences.*

Second, experts warn against an excessively broad delineation of the MCA, as that could lead to suburban development with much lower densities than are sustainable in a less car-dependent future. By assuming a tighter demarcation of the MCA, and by selecting a very limited number of growth centres within it, compact development can be facilitated through plan-imposed scarcities on the land market. The density problem could be tackled through a phased development policy for the MCA, in which the Brussels–Antwerp axis would be optimized first, before having it stretched to the entire MCA at a later stage, particularly towards the transport hubs of Lokeren, Dendermonde, and ultimately Ghent. Such a phased development exerts continuous pressure on land, housing, and business estate markets, and therefore provides an incentive to focus on higher quality, density, and efficiency.

Furthermore, the Brussels Capital Region remains a major employment centre, especially for specialist, office-based activities, but selective decentralization of such activities towards other cities should be considered. For non-specialist employment, it is clear that

the main purpose of job creation is to provide the local population with employment, aiming for more self-sufficiency in terms of economic needs at the level of the municipalities. For location policies for logistics and industrial activities, the presence of waterways, freight rail lines, and motorways is more important than the presence of high-quality public transport or the proximity of a large number of potential employees.

railway that is strategic for MCA, or (future) light railway (phase 1)

railway that is strategic for MCA (phase 2)

freight transport corridor that is strategic for MCA

high-frequency train service

inh./km²

0–20
21–50
51–100
101–200
201–500
501–1000
1001–2000
2001–5000
5001–44973

N

0   10 km

Figure 8: Spatial development perspective with regards to the transport system.

Finally, it is important to recognize that there are a number of barriers of an administrative or political nature that may prevent the desired reinforcement of the MCA. An important stakeholder that should be more involved in this and related planning processes, is the national railway company.

5.3 Transferability of the method

Some of the above conclusions are so specific that they cannot be deduced entirely from the insights offered by the agglomeration potential maps. However, the agglomeration potential maps played in important role in forging consensus about node development as being the most desirable spatial form of metropolization. On the one hand, this is a lot more specific than the principle of deconcentrated bundling that was used in the former policy plan, the Spatial Structure Plan for Flanders, while on the other hand, it is clear that the analytical tool of the agglomeration potential maps is at a too high scale to offer a concrete development perspective for each individual node.

We conclude that the use of the agglomeration potential maps has contributed to the conceptualization of a desirable form of metropolization of the MCA as a polycentric region, taking into account aspects of sustainability and liveability as predefined by policy makers. The added value lies in the possibility of visualizing what the spatial impact would be of reinforcing critical mass, which in turn could guide future compact development. The maps make the trade-offs involved tangible to the actors taking part in the planning process, which then provides them with the opportunity to augment the analysis with context-specific issues, constraints, and opportunities.

Although context-specific issues will vary from place to place, the agglomeration potential map tool can be of merit to the planning processes of other functionally polycentric regions. Nevertheless, we must recognize that the analytical tool is most insightful on the scalar level of the metropolitan region and less so for the individual locations therein. Follow-up research is currently focusing on mapping specific characteristics of the various railway station precincts, based on the node-place model (Caset et al., 2017). This analysis will allow us to classify railway station precincts according to suitability to the development of either additional housing, or activities that attract large numbers of visitors, and is a method that might well be applied to similar polycentric regions outside Belgium.

6. Conclusions

This paper reports on a planning exercise in Flanders that explored the usefulness of spatial-analytic methods in a deliberative planning process. The goal of this planning process is to reach consensus about the desired trade-off between agglomeration externalities and liveability concerns. The result is a polycentric development perspective for the metropolitan region. By combining insights from the literature on metropolization and optimal city size, a spatial analysis was performed that operationalized the newly gained insights into the Flemish MCA. This resulted in the tool of agglomeration potential maps. The agglomeration potential maps were subsequently employed as a decision support system in combination with local and specialized expertise in a visioning workshop.

Given the objective, outlined in the Green Paper on Spatial Policy, to optimize the balance between achieving positive agglomeration externalities and fostering liveability and sustainability, and given the geographical scope of the study, the visioning workshop focused on the mobilization of specialized expertise and on the achievement of a consensus. The agglomeration potential maps allowed narrowing the discussion to the politically salient choices that are inevitably part of any planning process. Spatial analysis performs the role of a focusing device rather than a definitive imposition of an optimal solution. A balance was sought between guidance through quantitative analyses, and a more intuitive way of exploiting existing expert knowledge. The result of the workshop is a new and overarching spatial vision, visualized by means of three spatial structure schemes.

The strength of the planning exercise outlined in this paper lies in this unique combination of analyses. Spatial analyses can never provide a singular answer to policy questions, as normative judgments permeate what is included in and excluded from the analysis (Van Meeteren, 2019). However, by operationalizng policy intentions, considering them in a geographical context, and confronting the resulting maps with expert knowledge, potential solutions can be worked out quickly. The resulting outcomes of the workshop have a high degree of realism attached to them that are consistent with the original policy priorities. Typical of a planning exercise such as this one is the strong dependence on ready knowledge among the actors involved. The agglomeration potential maps enriched the expert stakeholders' background knowledge in a way that helped in achieving the important task of spatial integration of various policy realms and associated objectives. We conclude that our conceptually derived and empirically sustained agglomeration potential maps were instrumental in turning the workshop into a decision-supportive rather than exploratory exercise, in seeking a balance between a quantitative and an intuitive approach and to a large extent reduced complexity. Rather than being a conveyor of rigidity in the planning process, spatial analysis can have a planning support mechanism that facilitates focus, communication, and collaboration across stakeholders (Pelzer et al., 2014).

In this way, the planning process was steered towards new and substantive insights, partly bridging the classic theoretical divide in planning between process and content. This attempt succeeded to a considerable extent, given the interest of the experts involved in the workshop in the agglomeration potential maps, and the significant degree of consensus achieved during the workshop concerning the employed preconditions of critical mass and TOD. At the same time, while believing in the potential power of the agglomeration potential maps to bridge the gap between planning support systems and expert opinion, the planning exercise underlines that the latter can only be nourished by the former. The exercise showed the potential of integrating spatial analysis measures in a deliberative planning context, not as director of the outcome, but as a channel for the discussions towards politically and policy defined goals.

Endnotes

[1] This is akin to Van Notten et al.'s (2003) assessment that scenario design needs to address three focal themes: project goal, process design, and scenario content.

[2] The Flemish Diamond was first defined in the Spatial Structure Plan for Flanders (Flemish Government, 1997/2004), the overarching policy plan for urban and regional development in the Flemish region since 1997. However, the term 'Flemish Diamond' has a hidden geopolitical charge, because Brussels is not fully politically or administratively part of Flanders, stirring controversy between the Flanders and Brussels regions. Yet, the odd situation is that Brussels is the capital of Flanders, making Flanders the only territorial entity in the world with an—in many policy domains—extra-territorial capital.

[3] Albrechts (2001) provides detail on the subsequent evolution of Flemish planning instruments in the 1990s.

[4] The authors were hired to support the planning process, see (Van Meeteren et al., 2015).

[5] This is not to be confused with 'population potential' or 'workplace potential', commonly used as accessibility or density measures calculated from single points (see Craig (1987) for a thorough explanation). The 'agglomeration potential maps' that we present visualize different population thresholds from the perspective of the four major city centres in the Flemish Diamond and give an indication of the interaction potential of a fragmented urban agglomeration.

[6] At a railway stop, typically no station services (such as the availability of other transport connections, ticket offices, shops, food services) are provided.

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