

# **Urban planning and transport infrastructure provision in the Randstad, Netherlands –**

A Global City Cluster

Prepared for the Roundtable on  
Integrated Transport Development Experiences Of Global City Clusters

(2-3 July 2015, Beijing China)

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**June 2015**

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## 1. INTRODUCTION

The Netherlands is a relatively small but densely populated country. The country covers an area of 37,354 km<sup>2</sup> and has a population approaching 17 million, which gives it a population density of 450 persons per square kilometre (Table 1). Despite its relatively modest size, it is the world's 17th largest economy with high levels of income per capita (United Nations 2014). The large majority of the country's population (around 75%) is resident in urban areas in the Netherlands (OECD 2014), especially in the west of the country in the Randstad metropolitan region. Although it is a prosperous country, car ownership is below the OECD and EU average (Table 2), and also below the levels of its two neighbouring countries – Belgium and Germany (OECD 2013, EU 2014). Nevertheless, road infrastructure in the Netherlands, especially in the Randstad metropolitan region, is heavily used, and road traffic intensity (measured in vehicle-kilometres per network length) is relatively high in comparison to other EU and OECD countries (OECD 2013).

The Randstad region is generally used to refer to a polycentric metropolitan area in the western part of the Netherlands, comprising the four largest Dutch cities (Amsterdam, Rotterdam, The Hague and Utrecht – sometimes termed the 'Big 4') as well as several medium-sized cities (Figure 1).<sup>1</sup> There are however no official boundaries for the Randstad region and it does not coincide with any of the three tiers of government in the Netherlands (state, province and municipality). Consequently, different delineations of the Randstad exist. More importantly, the Randstad has no institutional foundation and no formal powers of decision-making, which means that policy is rarely developed for the Randstad region in isolation. According to Meijers et al (forthcoming), the importance of the Randstad region in national policy discourses is closely related to the dominance of certain political parties in government.

Geographically, the Randstad is generally considered to consist of a less-densely populated, agricultural core (known as the Green Heart) surrounded by a ring of urban development approximately 80 kilometres in diameter. Although none of the Randstad's four largest cities contains more than 1 million inhabitants (the populations of Amsterdam, Rotterdam, The Hague and Utrecht are 825,000, 619,000, 510,000 and 330,000 respectively), the total population of the metropolitan region is close to 7 million, which makes it the fifth most populous metropolitan region in western Europe, after London, the Rhine-Ruhr metropolitan area, Paris and Milan (OECD 2007).

Unlike many other metropolitan areas in OECD countries, the Randstad does not have a single dominant core city. Instead, urban functions are distributed across the cities within the metropolitan region. National policy has purposely avoided concentrating functions and power in a single city. While Amsterdam and Rotterdam are the two largest cities in the Randstad, national government is located in The Hague, with the consequence that embassies and international organisations (such as the International Court of Justice) are also located there. Amsterdam has a leading position as a centre for culture and for financial and business services, while Rotterdam is the centre for various trade and industrial activities, many of which are connected to the city's port. Meanwhile, the city of Utrecht is located at the centre of the national railway network and home to various important service industries.

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<sup>1</sup> Polycentricity refers both to the morphology of urban areas, structured around several urban nodes, and to the existence of functional relationships between the cities and centres of such regions in terms of commuting flows, industrial and business relationships, forms of co-operation and the division of labour (OECD 2007).

*Table 1. Overview of economic, social and motorisation characteristics of the Netherlands compared to the USA and China*

	Netherlands	USA	China
Population (2013, millions) (global position)	16.8 (64)	313.9 (3)	1,357.4 (1)
GDP (2013, US\$ millions) (global position)	853,539 (17)	16,768,050 (1)	9,181,204 (2)
GDP per capita (2013, US\$) (global position)	50,930 (15)	52,392 (12)	6,626 (89)
Area (km <sup>2</sup> )	37,354	9,833,517	9,596,961
Population density (2013, persons per km <sup>2</sup> )	450	31	141
Population change, total (2004-2013)	3.2%	7.2%	4.4%
Population change, urban (2004-2010)	3.8%	--	22.6%
Motorisation (2011) (motor vehicles per 1,000 population)	527	783	120 (estimate)

Sources: United Nations 2013 and 2014; OECD 2013

*Table 2. Overview of economic, social and motorisation characteristics of the Netherlands compared to its near neighbours – Belgium and Germany*

	Netherlands	Belgium	Germany
Population (2013, millions) (global position)	16.8 (64)	10.30 (77)	80.22 (16)
GDP (2013, US\$ millions) (global position)	853,539 (17)	524,806 (24)	3,730,261 (4)
GDP per capita (2013, US\$) (global position)	50,930 (15)	47,261 (19)	45,091 (21)
Area (km <sup>2</sup> )	37,354	30,528	357,137
Population density (2013, persons per km <sup>2</sup> )	450	366	226
Population change, total (2004-2013)	3.2%	7.1%	-0.6%
Population change, urban (2004-2010)	3.8%	4.6%	--
Motorisation (2011) (motor vehicles per 1,000 population)	527	546	551

Sources: United Nations 2013 and 2014; OECD 2013

Figure 1. Location of the Randstad (coloured in darker blue)



Source: OECD 2007

The Randstad is of great economic and social significance to the Netherlands because, although it only covers 20% of the surface area of the country (according to most delineations), it accommodates more than 40% of the national population, and about half of the national income is earned in the region. Of the 25 largest cities in the Netherlands, 12 of them (four large and eight medium-sized cities) are located in the Randstad. The distances between the cities in the Randstad are relatively small – all cities are less than 75 kilometres apart and most are much closer. As a result, the cities in the Randstad are closely interconnected, particularly since they have different functions and specialisations. However, the extent of the interconnections between the cities in the metropolitan region remains the subject of debate. Some research suggests that the Randstad is not a single functional entity but rather a set of several functional regions (e.g. Cortie et al 1992, Clark & Kuijpers-Linde 1994, van Oort et al 2010). Nevertheless, the networked nature of the cities in the area, the close proximity of the cities, and their combination of complementary economic functions, are generally believed to increase agglomeration advantages for the whole area, and positively contribute to the Randstad's competitive position as an important global metropolitan region (Hall & Pain 2006, Meijers & Burger 2010).

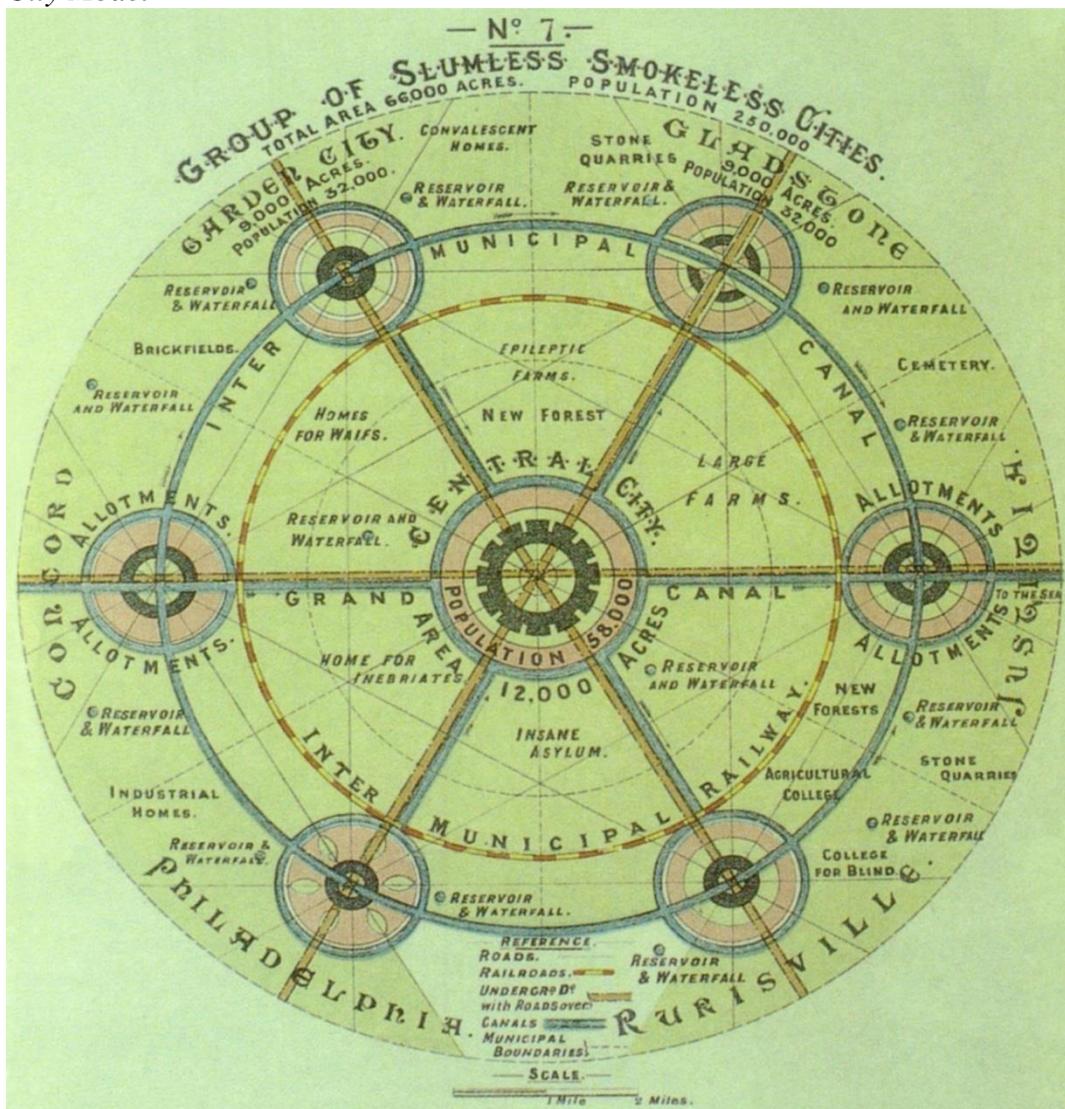
This paper describes the experiences and challenges of promoting urban development in the polycentric metropolitan area of the Randstad – an important European city cluster which is physically very different in nature to many other European city clusters (such as London or Paris) by virtue of the spread of functions and specialisations across the metropolitan region.

The paper is divided into six main parts, beginning with an overview of the theoretical underpinnings and debates about the agglomeration advantages of city clusters. Second, the role of transport in promoting agglomeration advantages is outlined. Third, the basic structure of the various passenger and freight transport networks are described. The fourth part presents a history of strategies that have been employed to manage the physical development of the Randstad, and the implications that these strategies have had for transport flows and infrastructure. Fifth, the paper discusses recent strategies and policies that have been introduced to promote more efficient transport operation in the Randstad, and some of the challenges that these strategies and policies face. Sixth, the paper identifies policy-relevant conclusions and recommendations from the Randstad, and considers the relevance of lessons from the Netherlands for other metropolitan city clusters around the world.

## 2. AGGLOMERATION ADVANTAGES IN CITY CLUSTERS

The belief that particular types or forms of spatial development in towns, cities and regions are more efficient or desirable has influenced urban planning theory and practice for more than a century. In other words, certain forms of spatial development were considered to have advantages over others for a range of social, economic or environmental reasons (e.g. urban sprawl, congestion, access to open space). At the turn of the 19th century, the Garden City model put forward by Ebenezer Howard, widely considered to be one of the founding fathers of urban planning, was constructed according to a polycentric structure containing a number of similarly-sized, connected cities. Howard's vision was that this constellation of urban development (essentially an urban network) would have distinct advantages over large cities and many of the problems that they experienced at the time (Figure 2).

*Figure 2. Early example linking polycentricity and urban performance: Howard's Garden City Model*



Whether urban networks and polycentric city clusters provide a remedy for a whole range of social, economic or environmental problems has not been conclusively established. There is currently a lack of systemic evidence about the full consequences (economic, social and environmental) of different types of metropolitan structure. We are only beginning to understand some of the wider implications of metropolitan structure on urban performance. To date, only a limited amount of evidence is available. Studies examining the transport

impacts of metropolitan structure include works of Cervero and Wu (1998) and Schwanen et al. (2004). Research by Veneri (2010) suggests that polycentric metropolitan development in Italian regions is potentially environmentally advantageous since it is associated with shorter distances between residences and workplaces, and lower CO<sub>2</sub> emissions due to commuting. As for the impacts of metropolitan structure on economic performance, authors such Cervero (2001), Lee & Gordon (2007) and Meijers & Burger (2010) have started to explore the issue. Some recent insights from the literature are summarised below. Before doing so, we consider the potential advantages of city clusters in terms of agglomeration externalities.

***City cluster advantages: a new, regional type of agglomeration externalities?***

*“[City] actors have the choice between independent ‘stand alone’ strategies where they perform all activities themselves usually at higher costs resulting in lower performance and strategies of co-operation which result in the transfer of activities and/or resources to other actors increasing a large range of types of dependencies but also improving their performance.”* (Capineri and Kamann, 1998:42).

The additional benefit of creating city networks is that it may result in specialization, redistributing resources and activities over the cities involved according to their comparative advantages and particular endowments. In theory, this means that the individual performance of cities improves as they can focus their efforts on the particular role they play in the regional network of cities, abandoning strategies to attain completeness and diversity at the individual-city scale. Classic network development theories also point to specialization as the outcome of a process of rationalization of the network structure once it has achieved a considerable level of complexity.

The extent to which this may be performance-enhancing is largely dependent on the question whether cities have something to offer that complements other cities, allowing them to ‘borrow size’ within the cluster (Alonso, 1973). This makes the issue of complementarity and diversity within the city cluster important. This point is made by Sassen in her work on city clusters in the US (which she refers to as ‘megaregions’):

*“The thesis is that a megaregion is sufficiently large and diverse so as to accommodate a far broader range of types of agglomeration economies and geographic settings than it typically does today. This would take the advantages of megaregional location beyond the notion of urbanization economies. A megaregion can then be seen as a scale that can benefit from the fact that our complex economies need diverse types of agglomeration economies and geographic settings, from extremely high agglomeration economies evinced by the specialized advanced corporate services to the fairly modest economies evinced by suburban office parks and regional labor-intensive low wage manufacturing. It can incorporate this diversity into a single economic megazone.”* (Sassen, 2007:60).

It is not just the extremely wide diversity in terms of agglomeration economies and geographic environments offered at the scale of large city clusters that matters. What is equally important is that these are ‘within reach’ of each other. While different activities of firms spread to places that best fit the type of business environment that caters to their needs, it will always be the case that some of their activities that are inseparably linked to the core activities would profit from other types of agglomeration economies not present locally.

It is widely acknowledged that the Randstad is an archetypal example of a city cluster characterised by a complementary network of specialized centres (Camagni and Salone, 1993; Van der Knaap, 1994; Meijers, 2005, 2007; Cowell, 2010). Much of the complementary nature of the network is historical, but has also become an objective of urban development policies, particularly since the rise of the ‘smart specialisation’ paradigm. For instance, The Hague is establishing a development zone aimed at international organisations, Amsterdam is promoting a prime location for headquarter offices (the South axis), while Rotterdam is investing in new port and industrial areas.

A simple example to illustrate the point about city cluster advantages. A new firm decides to locate in The Hague to be close to international institutions. The location means that the firm has easy access to advanced producer services, cultural amenities and Amsterdam Schiphol airport. Meanwhile, the firm's employees can choose to live in a modern high-rise apartment in Rotterdam or in a university town, such as Delft, Leiden or Utrecht. In other words, the other cities in the city cluster add to the attractiveness of The Hague and vice versa, leading to better performance. Such processes are increasingly being referred to as 'borrowed size'.

#### ***'Borrowed size' and 'agglomeration shadows'***

In its original conceptualisation by Alonso (1973), the concept of 'borrowed size' describes and explains the situation whereby smaller cities located in a larger 'megapolitan complex' perform more favourably through access to agglomeration benefits offered by larger neighbouring cities. Alonso spoke of small cities exhibiting some of the *characteristics* of a nearby larger city. Contrary to Alonso's original conceptualisation, there does not appear to be a compelling reason to reserve the borrowed size concept (functions, performance) for small cities in city clusters, in the sense that different agglomeration externalities can be borrowed by small and large cities alike, as well as on various scales, also beyond that of city clusters. Analysis by Meijers and Burger (forthcoming) suggests that borrowed size is less a product of distance or access than it is of true interaction. This is discussed in more detail below.

Contrary to what the borrowed size concept might suggest, being located close to other cities in city clusters is not necessarily positive. This negative effect is captured by the concept of 'agglomeration shadows', a shadow effect of agglomerations over their surroundings, which means that growth in neighbouring higher-tier cities is limited due to competition effects (Dobkins and Ioannides, 2001; Krugman, 1993). Neighbouring cities may cast an agglomeration shadow, consequently limiting development opportunities. This conception of agglomeration shadows is thus the opposite of the notion of borrowed size.

#### ***City cluster advantages and disadvantages: the influence of dominant cities***

Research by Veneri & Buralassi (2012) suggests that a dominant prime city (i.e. exhibiting a higher degree of monocentricity) increases agglomeration benefits. This conforms to the general finding that an increase in city size leads to more agglomeration benefits (see for example the meta-analysis by Melo et al. 2009 which claims that a city double the size of another is more productive by an average 5.8%). Veneri & Buralassi (2012) report that a high degree of functional polycentricity (measured as a balanced spread of centralities in terms of incoming flows) is associated with a higher level of labour productivity, but has a negative association with labour productivity growth. Meanwhile, Brezzi & Veneri (2015) report that metropolitan regions in OECD countries with a more dominant city are characterised by higher GDP per capita.

However, quite different conclusions about the role of dominant prime cities on city cluster advantages and disadvantages have also been reported. Van Oort et al. (2015), for example, find that there is a positive association between polycentricity and productivity growth, and Meijers & Burger (2010) report that polycentric metropolitan areas are associated with higher levels of labour productivity. However, this does not imply that polycentric metropolitan areas have more agglomeration benefits. On the contrary, research consistently shows that the spatial, institutional and cultural fragmentation inherent to polycentric urban systems implies that they cannot exploit their critical mass to the same extent as single large cities. Polycentric regions that fare better than others share a variety of common characteristics: their constituent centres are closer together, retail development is concentrated in one centre (i.e. a less polycentric distribution of retail compared to the population distribution), and where competition from centres outside the region is lower (Burger et al., 2014).

### **3. THE ROLE OF TRANSPORT POLICY IN ACHIEVING AGGLOMERATION ADVANTAGES IN CITY CLUSTERS**

There are many reasons to assume that transport and infrastructure play a key role within city clusters. Synergy is generally described as ‘the rise in performance of a network through efficient and effective interaction’, so synergies in city clusters depend on interaction, facilitated by transport and infrastructure policy. Spatial interaction could be interpreted as both a factor stimulating economic performance, as well as an indicator of economic performance. Edward Ullman (1956), a transport geographer who laid the foundations of spatial interaction models, explained spatial interaction between places as the result of three factors: complementarity, transferability and intervening opportunities. Complementarity (or a surplus in one place of something that is in demand in another) provides the basis for interaction. As such, interaction can be seen as an indicator of economic performance in city clusters, as it provides evidence of complementarities. His second precondition for spatial interaction, transferability, depends on the (communication) infrastructure and transit systems within the region and the costs to overcome distances between cities. The third dimension, intervening opportunities, is related to the existence of other nearby cities that may offer a better alternative for interaction. Ignoring this dimension can lead to a severe underestimation of the level of integration in a polycentric system.

There are more reasons to assume that transport and infrastructure have a prominent role in the performance of city clusters. More generally, there is the notion that networks may substitute for proximity (Johansson and Quigley, 2004). Transferring this principle to city clusters would imply that the benefits of agglomeration (proximity) could be increased in a cluster of cities that are strongly networked. The role of interaction in networks of cities on their performance has been highlighted by various authors (e.g. Capello, 2000; Boix and Trullen, 2007) but attention has mainly been devoted to establishing the importance of the embeddedness of cities in international networks for their performance (Taylor, 2003; Bel and Fageda, 2008; Neal, 2013; Meijers et al., forthcoming).

Two recent studies have focused on spatial integration between cities at the regional scale. In the first of these studies, Meijers and Burger (forthcoming) report that cities which are strongly integrated with other cities perform better than cities that are only moderately or weakly integrated with neighbouring cities. Their conclusion is that a higher degree of functional integration between neighbouring cities can override the negative effects of competition, diminishing agglomeration shadows. Clearly, the role of transport policy is important for functional integration between cities. In the second study, Meijers et al. (2015) conclude that functional integration is positively related to performance. Greater functional integration allows cities to better exploit their aggregate urban size, leading to more agglomeration benefits. This relationship is also significant also when other types of integration (e.g. cultural or institutional) are included in the analysis. While it is not theoretically very surprising that these two analyses show that more interaction/integration between clusters of cities is beneficial for agglomeration benefits, these studies are two of the first to empirically substantiate the issue.

#### 4. THE TRANSPORT SYSTEM AND INFRASTRUCTURE DEVELOPMENT IN THE RANDSTAD

The transport infrastructure network in the Netherlands is dense and modern. According to the World Economic Forum's Global Competitiveness Report 2014-2015, Dutch transport infrastructure is ranked fourth in the world (World Economic Forum 2015). Trade and logistics are two of the main economic sectors for the country as a whole and for the Randstad in particular. The region is a key transport hub for both aviation and shipping, being the home to the port of Rotterdam, one of the largest harbours in the world, and Amsterdam Schiphol airport, one of Europe's busiest airports. The hub function has helped to attract many foreign companies to the region and has increased the international profile of the Randstad's economy: the area currently receives approximately 60% of all foreign direct investment in the Netherlands and accounts for around three quarters of all Dutch exports (OECD 2007).

With a total road network of 139,295km, including 2,758 km of expressways, the Netherlands has one of the densest road networks in the world. The country also has a well-developed railway network which connects most major towns and cities, as well as a comprehensive dedicated cycling infrastructure network. Passenger transport is close to 200 billion km travelled per year, three quarters of which are by car (Table 3). Around half of all trips in the Netherlands are made by car, 25% by bicycle, 20% walking, and 5% by public transport. In 2013, Dutch airports handled 58 million passengers. Excluding air travel, the average person travels more than 30 kilometres per day, taking just over an hour.

*Table 3. Passenger transport modal share, Netherlands, 2012*

	Car driver	Car passenger	Train	Bus/ tram/ metro	Scooter	Bicycle	Foot	Other	Total
<i>Passenger-kilometres (x10<sup>9</sup>)</i>	95.2	41.2	13.6	4.6	1.1	14.8	5.2	10.3	186.0
<i>%</i>	51.2	22.2	7.3	2.5	0.6	8.0	2.8	5.5	100.0

The port of Rotterdam is the world's largest seaport outside East Asia, and is the largest port in Europe providing a connection to Germany, Switzerland and France via the Rhine and Meuse rivers. Two thirds of all inland water freight within the EU, and 40% of containers pass through the Netherlands. In 2010, 1.65 billion tons of goods traffic was transported in the Netherlands, half of which was moved by water (sea and inland shipping) and 40% by road transport. The remainder was transported by pipelines and rail, the latter accounting for only 2% of freight movements through the Netherlands.

Commuting patterns in the Netherlands are often within city-regions rather than between them (although there is a considerable amount of commuting between Amsterdam and Utrecht, and between The Hague and Rotterdam). Travelling beyond municipal or city-region borders has increased very little over recent decades, particularly across the Randstad as a whole (CBS 2006). Of the increases in commuting between city-regions in the Randstad that have occurred, many have been driven by changes in highly skilled workers (Burger et al., 2014).

##### ***Road transport infrastructure***

With 139,295 km of public roads, the Netherlands has one of the densest road networks in the world – denser than Germany and France although not as dense as Belgium. Dutch roads include 2,758 km of motorways and expressways, and with a motorway density of 64 kilometres per 1,000 km<sup>2</sup>. Car ownership in the Netherlands is lower than in surrounding countries and the European average. Goods vehicles account for 20% of total traffic.

##### ***Cycling infrastructure***

Cycling is a very popular mode of transport in the Netherlands. Most people in the Netherlands own at least one bicycle and many own more than one. It is estimated that there are at least 18 million bikes in the country, which equates to just over one per capita, which is more than twice as high as the level of car ownership. Almost a third of Dutch residents use the bicycle as their main mode of transport for daily activities. Around a quarter of all journeys are made by bicycle. Almost as many passenger kilometres are covered by bicycle as by train in the Netherlands.

In 2013, the European Cyclists' Federation ranked the Netherlands, together with Denmark as the most bicycle-friendly country in Europe. Cycling infrastructure is comprehensive, signposted, maintained and well lit. Dedicated cycle paths are common on busy roads - around 35,000 km of cycle routes are physically segregated from motor traffic. Busy junctions often give priority to cyclists, or are equipped with cycle-specific traffic lights. There are large bicycle parking facilities, particularly in city centres and at train stations.

### ***Rail transport infrastructure***

Most distance travelled by public transport in the Netherlands is by rail. The country has a dense railway network, totalling 6,830 kilometres of track, or 3,013 route km, three quarters of which is electrified. The network is mostly focused on passenger transport and connects virtually all major towns and cities in the Netherlands (Figure 3). The national rail infrastructure is managed by a public company, ProRail, and a number of different operators have concessions to run trains on the track.

Passenger rail services are mainly operated by Dutch Railways (Nederlandse Spoorwegen, or NS). A smaller number of services is provided by other operators (Arriva, Syntus, Connexion, Breng, DB Regio, NMBS, Veolia and DB Regionalbahn Westfalen). On weekdays almost all railway stations are serviced at least twice an hour in each direction. Large parts of the network are serviced by two to four trains per hour on average. Heavily used routes (most parts of the Randstad) are serviced up to 8 trains an hour. Per kilometre of track, the Dutch rail network is the busiest in the EU, handling over a million passengers a day.

Figure 3. Dutch rail network



Major investments have been made in station reconstruction and expansion work at the four largest railway stations in the Netherlands, the central stations of each of the largest cities: Amsterdam, Rotterdam, The Hague and Utrecht. The rebuilding of Rotterdam Central was completed in March 2014; work on the other three stations is ongoing.

Of the 3,013 km of route-km in the Netherlands, just over 120 km are for use by high-speed trains. The High-Speed Line South (*Hogesnelheidslijn Zuid* or *HSL-Zuid*) links Amsterdam, Schiphol Airport and Rotterdam with stations in Belgium (Antwerp and Brussels) and France (including Paris and Lille). The line also has a branch to Breda. Originally scheduled to be in

service by 2007, the first public operations began in 2009. The opening of the line has helped to reduce travel times in the Randstad, particularly between Rotterdam and Amsterdam where travel times have been cut by more than 20%. Regular rail tickets are valid on domestic high-speed services (Amsterdam-Schiphol-Rotterdam-Breda) but a supplement is required between Schiphol airport and Rotterdam. To date, however, the use of the service has been lower than expected.

#### ***Other public transport infrastructure***

Public transport is operated by city-run operators in Amsterdam, Rotterdam and The Hague, whereas private companies are franchised to provide public transport services in other parts of the country. Long-distance bus services are uncommon. Regional/rural public transport, serving smaller towns is by mainly bus. In a small number of cities, metro, light rail and tram services are available (Amsterdam and Rotterdam have both metro and tram systems; The Hague has a tram system). Rotterdam and The Hague are connected by a light rail system (RandstadRail). Utrecht has a light rail system, connecting the city with adjacent towns.

#### ***Water transport infrastructure***

The Netherlands has thirteen seaports, three of which have international significance. Handling 440 million metric tons of cargo in 2013, the port of Rotterdam is the biggest port of Europe - as big as the next three biggest ports combined, and one of the largest in the world. The Amsterdam seaport is the second most important in the country, and the fifth largest in Europe. Three Dutch ports are deep-water ports, Rotterdam, Zeeland Seaports and IJmuiden, and are capable of handling fully laden Panamax ships.

Through the rivers Rhine and Meuse, Rotterdam has excellent access to its hinterland upstream, reaching to Germany, France and Switzerland. The port's main activities are petrochemical industries and general cargo handling and trans-shipment. The harbour functions as an important transit point for bulk materials and between the European continent and overseas. From Rotterdam goods are transported by ship, river barge, train or road. In 2007, the *Betuwelijn*, a new, dedicated freight railway from Rotterdam to Germany, was completed.

Across the country, 6,237 km of rivers and canals are navigable for ships of up to 50 tons in size. Some 3,740 km of this consists of canals. The Dutch inland shipping fleet is the biggest in Europe. Consisting of some 7,000 vessels, it takes a share of 35% of the national total annual freight, and as much as 80% of bulk transport. Two thirds of all inland water freight in the EU pass through the Netherlands. Virtually all major industrial areas and population centres can be reached by water via inland ports and transshipment terminals (Figure 4).



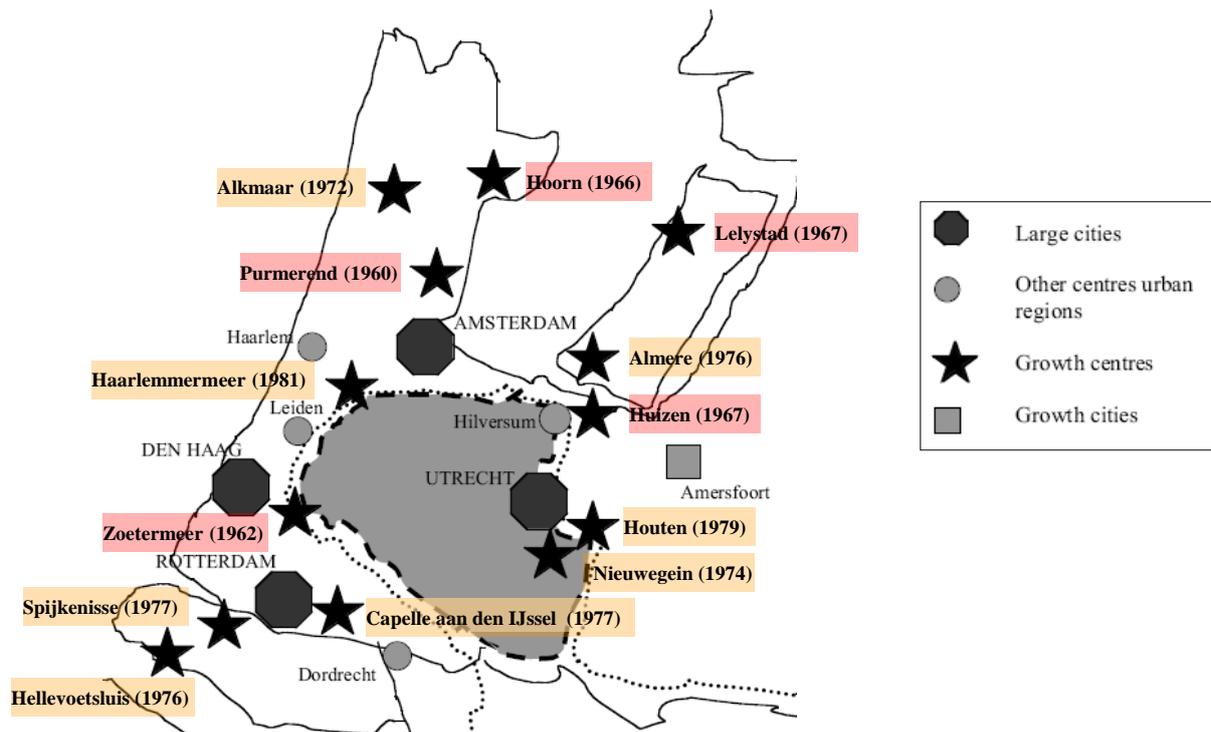
#### **4. SPATIAL DEVELOPMENT IN THE RANDSTAD: POLYCENTRIC METROPOLITAN DEVELOPMENT**

Planning is an important part of Dutch society and culture (Shetter 1988) and, for many decades, urban and regional policy in the Netherlands has aimed to limit the growth and physical expansion of cities with the aim of achieving various social, environmental and economic goals. Underlying these policies was the idea that certain forms of spatial development have advantages over others (see above). Dutch policymakers have attempted to promote more compact forms of urbanisation in different shapes and forms through urban planning policy. The most important reasons for doing so include reducing urban and suburban sprawl, protecting natural resources and open space, limiting increases in car use, and strengthening urban functions in cities (varying from local shops to museums) (Bartelds and De Roo 1995; Faludi and van der Valk 1994). Different strategies to achieve compact urban development have played a prominent role in various Dutch national spatial policy documents. As noted in the introduction, national policy on urban and regional development has purposely avoided concentrating functions and power in a single city. Instead, functions and power have been spread across multiple cities, with the consequence that a different set of economic sectors are important for each city.

Shortly after the end of World War II, the Working Commission for the Western Netherlands was founded to discuss the development of the region which is now often referred to as the Randstad. In their report of 1958, the Working Commission defined the region in terms of two large urban agglomerations (north and south), and recommended that the groups of cities making up these agglomerations should be prevented from coalescing by means of green buffer zones. Urban growth was directed towards new towns at the exterior of both wings. The Commission also recommended that the large open area situated at the centre of the urban ring, the Green Heart, should be protected, primarily for agricultural reasons. Later, the recommendations of the Commission were elaborated in the First Memorandum on Spatial Planning (1960) in which the main emphasis was on a policy of population and economic dispersal, achieved by providing incentives to firms moving to problem areas and by decentralising government institutions away from the Randstad. This was a response to the rapid economic development of the Randstad at the time, and low economic performance in other parts of the Netherlands, which resulted in regional imbalances in prosperity and migration flows to the Randstad (Quist, 1993).

The Second Memorandum on Spatial Planning (1965) aimed to limit population growth in the western part of the Netherlands and redirect it to the north and south of the country. The Memorandum attempted to address and restrict the suburban sprawl that was taking place in the Green Heart. At the same time, under the policy of ‘concentrated deconcentration’, urban growth in the Randstad was planned in suburban areas around the four largest cities. By the 1970s, this policy was extended, leading to the identification and subsequent development of growth centres (new towns) further away from the major cities (Figure 5). The policy of concentrated deconcentration was primarily seen as a means of preventing uncontrolled urban sprawl in the Randstad. Many of the new towns were connected to existing settlements by constructing new railway lines and stations. However, most of them became car-oriented.

*Figure 5. Location of growth centres (and start date) in the Randstad region*



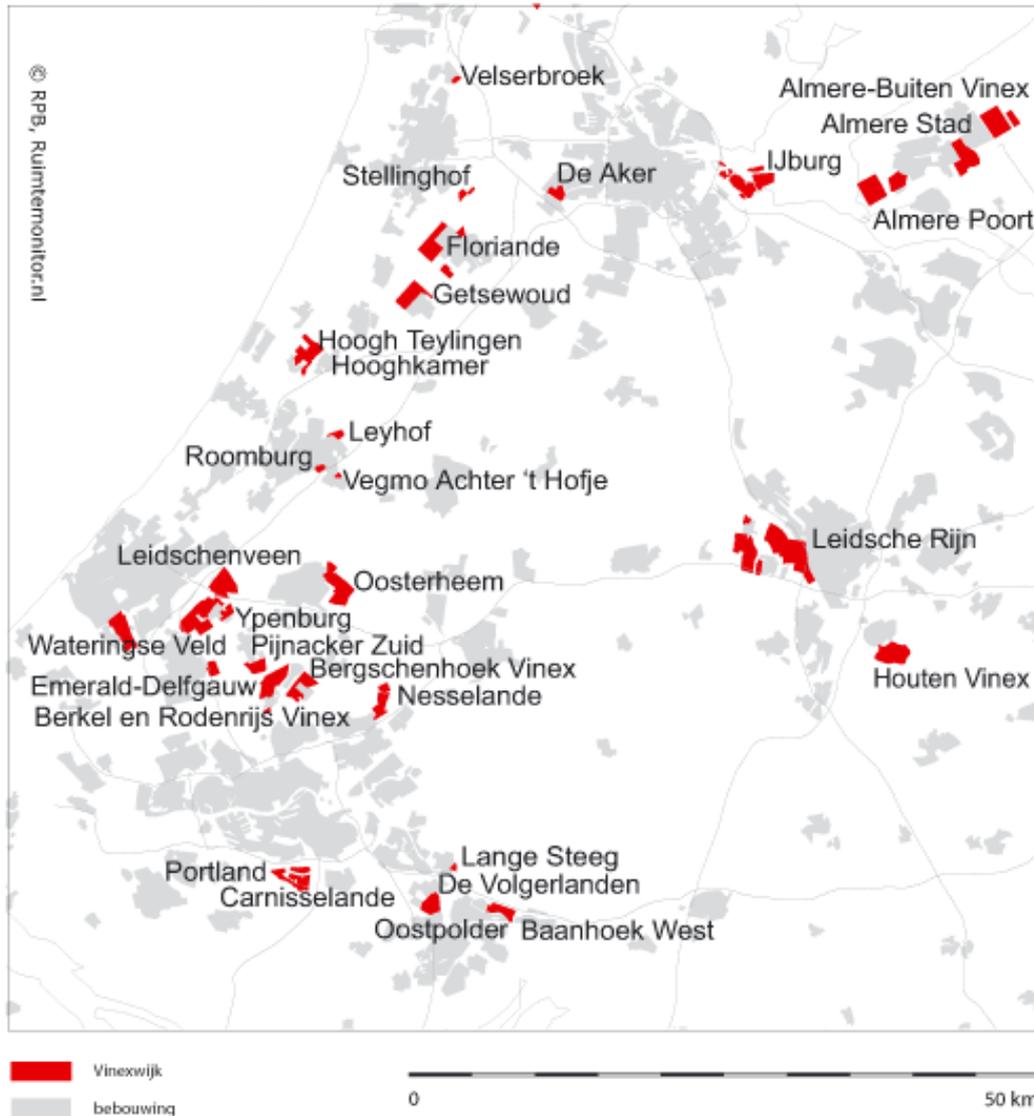
Based on Bontje 2003

By the mid-1970s, concerns were raised about the possible negative impacts of concentrated deconcentration policy for the larger cities. More specifically, there were concerns that suburban expansion and the development of growth centres were detrimental (socially, economically and environmentally) to existing urban cores. While successful in terms of concentrating suburban growth in designated areas, the policy of concentrated deconcentration was also contributing to declines in population, public services, employment, and income in urban cores. Reflecting these concerns, the Third Memorandum on Spatial Planning (1976) emphasised the improvement of existing urban areas by concentrating and intensifying developments within urban areas, rather than at the fringes of the Randstad. This policy shift was accompanied by a redefinition and new demarcation of the Green Heart as an area for protection against development. During the 1980s, increased concerns about the decline of urban cores after several decades of suburbanisation led to a death blow to the policy of concentrated deconcentration. The decentralization of firms under the policy of concentrated deconcentration is thought to have contributed substantially to the large increase in distances travelled by car since the 1960s (Alpkokin 2012).

Towards the end of the 1980s, the Fourth Memorandum on Spatial Planning (1988) was presented in which the 'compact city' policy concept was introduced. A central aim of the policy was to put a brake on the urban exodus of population and employment, and to intensify and optimise development within existing urban areas, including development on brownfield (previously developed) sites and the densification of existing suburbs. The Fourth Memorandum also set out a firm location policy (ABC policy), requiring minimum levels of accessibility by public transport and car for different types of employment (Schwanen et al 2004). Alongside the switch in focus from concentrated deconcentration to compact urban growth, the Fourth Memorandum also paid close attention to the international competitiveness of the Randstad, particularly in relation to other metropolitan regions in North West Europe. The Randstad's decentralised and dispersed structure was seen as a favourable and unique asset, particularly the Green Heart and the buffer zones between urban areas. On the other hand, the decentralised structure increased the demand for transport infrastructure. In the early 1990s, the compact city policy was further elaborated (in a supplementary report to the Fourth

Memorandum on Spatial Planning, VINEX), guiding urban development to locations within cities or sites directly adjacent to existing cities in order to reduce the need to travel long distances (Figure 6). However, public transport provision to these sites was not often provided at the outset, requiring residents to use other modes of transport for many journeys, which then proved difficult to reverse once public transport services were put into place.

Figure 6. Location of urban expansion areas in the Randstad under the VINEX policy



Source: RPB 2006

As well as an increase in residential developments at the edge of cities following VINEX policy, there was also a strong growth in commercial areas in similar locations, especially in the immediate vicinity of motorway junctions and access roads. Between 2000 and 2006, more than one third (about 60 km<sup>2</sup>) of new urban development was for commercial and industrial purposes (Ritsema van Eck et al 2009). These developments were often poorly served by public transport with negative impacts for traffic and emission levels for the area.

By the late 1990s, the networked nature of urban areas in the Randstad increased in importance in national planning policy. The recognition of the Randstad as an interconnected urban network forming a large metropolitan system led to a conceptual switch from the compact city policy to the ‘network city’ policy. Three large network cities in the Randstad were distinguished in policy: Amsterdam, Utrecht and the South Wing (The Hague and Rotterdam). The aim of the network city was to develop and strengthen these urban networks by means of new development to improve the profile and performance of the network cities, and new infrastructure to increase accessibility both within these networks and between them. The network city policy was also reflected in the Fifth Memorandum on Spatial Planning (2001) but focused on the Randstad as a whole rather than on individual city regions within the Randstad. The Randstad was identified as one of six main metropolitan networks of national and international importance in the Netherlands (Figure 7).

*Figure 7. Metropolitan networks identified in the Fifth Memorandum on Spatial Planning*



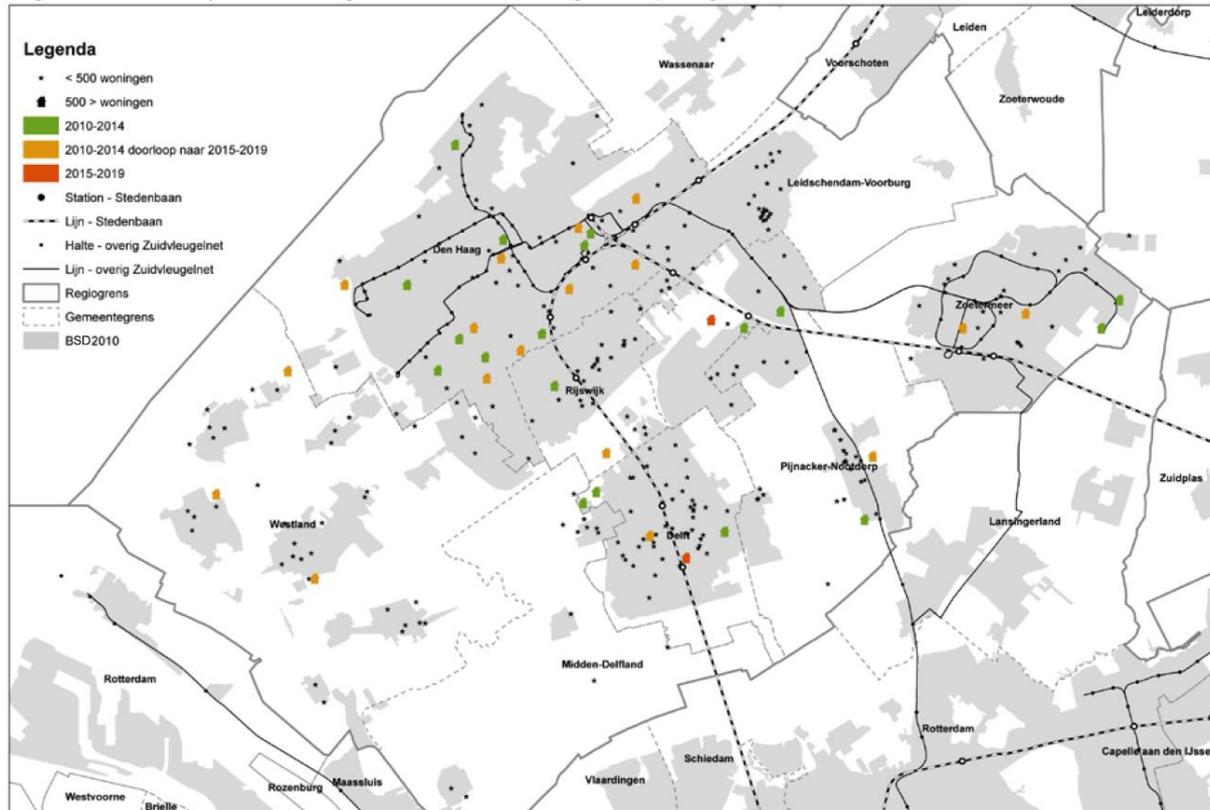
Source: van den Burg & Dieleman 2004

In its successor to the Fifth Memorandum, the National Planning Strategy, adopted in 2006, marked a departure from earlier, more restrictive planning discourse. It also made a break with the centralist tradition in which national government determined in some detail what would get built and where. This document signalled a shift in emphasis from comprehensive planning to a more piecemeal approach. In terms of development locations, the Strategy proposed that urban growth should be accommodated along major transport corridors in order to reduce congestion and enhance economic performance. The concept of urban networks, contained in the Fifth Memorandum, was also included in the new National Planning Strategy.

The new Spatial Planning Act, adopted in 2008, further paved the way for a more decentralized approach to urban planning, in which regional and local authorities were given greater powers to decide on urban growth policies. Under the current National Structural Vision, adopted in 2012, the coordination and implementation of urbanisation plans is the primarily the responsibility of local authorities. Central government no longer has a strong hold on the course of urban planning, with the possible exception of regions around major transport hubs in the Randstad, where central government has a role in agreeing the programming of urbanisation together with local and regional authorities. National planning policies related to national buffer zones, urban concentration and densification have been abolished. In general, these changes involving the decentralisation of planning powers to regional and local authorities have resulted in smaller-scale urban development projects being proposed (Figure 8). The economic downturn and lower levels of population growth have also contributed to this trend in smaller-scale urban development projects. A key aim of the liberalisation and decentralisation of urban planning policy is to strengthen the urban economy by stimulating 'agglomeration economies' (achieved in larger urban systems).

Despite restrictive policies on the location of retail development, there has been a considerable increase in retail functions in the urban fringe over recent years. However, in general, the development of large out-of-town shopping areas has generally been resisted, unlike in many other countries in Europe. Whether this situation will continue in the next years and decades is unclear, however, particularly since local and regional authorities now have more powers to make decisions for this type of development under the current Spatial Planning Act.

Figure 8. Plans for urban growth in The Hague city region, 2010-2020



Source: Bestuurlijk Platform Zuidvleugel 2010

## 6. POLICIES FOR MANAGING TRANSPORT INFRASTRUCTURE

Various national government policies over the last few decades have been directed towards strengthening the hub function of the Netherlands and increasing accessibility. Examples in the Randstad include the extension of the port of Rotterdam (*Tweede Maasvlakte*), the freight transport line connecting the port of Rotterdam with Germany (*Betuwelijn*), capacity increases (for landing and handling) at Amsterdam Schiphol airport (*Polderbaan* and *Pier A*) and the construction of the High-Speed Line South (*HSL-Zuid*, see above).

For more than a decade now, infrastructure policy is increasingly determining urban development in the Randstad. The dominance of housing policy and new housing locations has been losing ground. The official policy is that housing must be situated in built-up urban areas. In reality, small concentrations of new housing have also been built on greenfield sites. However, since the economic downturn, the development of housing, offices, shops and other urban amenities decreased considerably.

Since June 2012, the National Policy Strategy for Infrastructure and Spatial Planning (SVIR) came into force. This plan represents a strategic agenda for spatial planning policies and outlines the government's programme of investments. The SVIR identifies a list of national priorities to be followed by the central administration (various ministerial departments and government agencies). A related instrument, the Multi-Year Plan for Infrastructure, Spatial Planning and Transport (MIRT), is an investment programme set up by the national government with the goal to improve the coherence between investments in spatial planning, economic development, mobility and liveability at the national level. The rules laid down under the MIRT specify the main process steps for projects and programmes wishing to qualify for government funding. National and local officials meet annually to discuss a shared vision by national and regional authorities. As such, MIRT contributes to the regional agenda, providing long-term investment framework for infrastructure development and/or improvements (Figure 9). Improving accessibility is a key priority for projects in the Randstad.

In the southern part of the Randstad, the Province of South-Holland has been promoting the *Stedenbaan* initiative – a form of Transit-Oriented Development (TOD) on the railway network between The Hague, Rotterdam and Dordrecht. This has partly been a response to the creation of additional network capacity for local and regional rail services as a result of running intercity train services on the High-Speed Line South (see above). Proposals have been formulated to intensify and diversify development in and around station areas across the network: housing, offices, hotel accommodation, meeting places, shops, bus stations, parking areas for cars and bicycles and improving the public space. The intention of the initiative is to increase both the place and node value of station areas, to increase the number of rail passengers and to improve the urban quality (Spaans & Stead, forthcoming). Another important aspect of the initiative is the creation of high-frequency, metro-style services with minimal waiting times between trains.

Figure 9. Projects implemented under the Multi-Year Plan for Infrastructure, Spatial Planning and Transport (MIRT)



In terms of managing the road capacity, road pricing was under discussion and preparation for a long time in the Netherlands. The proposal was to charge car users for each kilometre driven, with higher charges for more polluting cars and for driving during peak hours and on more congested roads. However, the scheme was abandoned a few years ago, after extensive planning, due to a lack of political courage and the shadow of the economic downturn.

In contrast to many monocentric metropolitan areas, the Randstad has never had an integrated system of public transport connections due to the fact that local authorities are more powerful than the regional governments, and local interests often take precedence in transport planning. Unlike monocentric regions, the Randstad has no dominant core to which the edges have to be connected. The consequence is that public transport systems in the Randstad are not as well integrated as they could be (OECD 2007). Nevertheless, the system is well-integrated in the sense of ticketing and information provision. Public transport journeys across the whole country can be made using a single chipcard, and integrated public transport information for the whole country is available, including door-to-door planning and real-time travel information via the internet.

## 7. CONCLUSIONS: POLICY IMPLICATIONS AND LESSONS

### *Principles for transportation and infrastructure development policies in city clusters*

- Generally, the stronger functionally integrated cities in city clusters are, the better the economic performance of the cluster of cities as a whole. Transportation and infrastructure development in city clusters cannot be decoupled from urban development strategies. Complementarity between cities implies that a complete set of metropolitan functions is present in the city cluster rather than in individual cities. Since these functions have supra-local significance, they need to be positioned in locations that are accessible across the region. The same holds for major new residential areas which need to be planned in such a way that regional connectivity is optimised. This in turn requires a metropolitan (rather than local) strategy on urban development and transport planning.
- A metro-like system is generally beneficial in city clusters. In practice, this implies frequent connections between cities, to such an extent that timetables are not required as waiting times between train services are low. However, heavy rail, rather than light-rail, is likely to be better suited to a transit system serving city clusters. Light-rail can be used as a feeder system to heavy rail in individual cities. As regards heavy rail, a combination of fast intercity-connections serving the main cities, and slower trains serving smaller settlements in between are essential. This requires multiple-track systems. High-speed trains are a desirable option in larger city clusters, but the maximum speed may be of less importance than frequency.
- Traditionally, road and rail infrastructure has a radial pattern in city-regions. In city clusters tangential infrastructure systems are often more important. One effective model is a metropolitan loop connecting all the main cities of a city cluster. Clearly this model is dependent on the situation of cities with respect to each other. Such systems have great symbolic importance in promoting the unity of city clusters, which in turn can foster greater integration. Transit oriented development is also important in city clusters; transit nodes should be regarded as ‘interaction environments’.
- City clusters should not necessarily be seen as ‘daily urban systems’. Some may act more as ‘weekly’ or ‘monthly urban systems’, implying that the maximum time people are willing to spend travelling is higher than the threshold generally applied for daily urban systems. Strategic functions (i.e. metropolitan functions of supra-local importance) should be located in the most accessible areas for the whole urban network. Disentangling local and metropolitan through-traffic, both in road and rail infrastructure, may have benefits for the performance of city clusters.

### *Does the situation in the Randstad conform to these principles?*

- The rail system in the Randstad generally works well. The frequency of trains is such that it almost functions as a metro-system, especially during the day. Trains also run during the night. In addition, large investments have been made in stations and station areas in almost all Dutch cities. Not only has this raised the status and appeal of travelling by train, much care has also been taken to integrate different modes of transportation at stations. This includes cycling; many stations have extensive parking facilities for cyclists. The bicycle is of importance as it enlarges the typical catchment area of stations from 500-800

metres (a 10-minute walk) to 3 kilometers (a 10-minute cycle journey). A notable success is the recent opening of the light-rail system between The Hague and Rotterdam (RandstadRail), linking the city region together.

- Transit-oriented development principles are also commonly applied. Increasingly, transport and infrastructure is also a critical concern when planning new urban development. In the past, however, new housing developments have been located close to highways, and have not been adequately connected to public transport networks. One estimate suggests that over 30% of the new housing areas in the Randstad do not have public transport facilities within a 10-minute walk. (Snellen et al., 2005) As a consequence, people in these new housing areas travel more by car than by public transport. Recently, there is a greater awareness of the importance of regional rather than local accessibility when planning new development. However, with the decentralisation of planning competencies to lower tiers of government, it has become more complicated to develop integrated spatial strategies for the Randstad, although several co-operation and discussion platforms in the Randstad still exist.
- There are missed opportunities when it comes to high-speed rail. The development of the high-speed train connection between Amsterdam, Amsterdam Schiphol Airport and Rotterdam, and onwards to Brussels and Paris, has had many problems. Delivery of the infrastructure was late and expensive. The winner of the concession to run the train services (Dutch national railways) had insufficient funds to purchase high quality rolling stock after spending a large proportion of the budget in acquiring the concession. There were technical problems with the rolling stock purchased. In practice, trains which are hardly faster than regular intercity trains now operate on the route. This means that the great potential that the line has to connect the northern and southern parts of the Randstad, and reap the economic benefits of integration in the Randstad, has not been fully exploited. Another missed opportunity is that the Randstad would benefit more from a 'loop' system, connecting all four main cities in the region: Amsterdam, Rotterdam, The Hague and Utrecht. The 'Randstad loop' ('rondje Randstad') was discussed 10-15 years ago but is no longer on the national policy agenda.
- Road accessibility and the high level of congestion has often been identified as one of the major problems of the Randstad by various observers (e.g. OECD 2007). Major spending in on road improvements, mainly increasing capacity by adding lanes, adding missing links in the network and creating by-passes, as well as improving dynamic traffic management systems, has substantially limited the level of congestion, even though the total volume of traffic has increased.

## **8. QUESTIONS FOR THE ROUNDTABLE**

- Should long distance and short distance traffic be regulated separately? To what extent might this affect the performance of city clusters?
- How can infrastructure networks be prevented from fragmenting landscape and damaging natural areas?
- How can urban development be controlled effectively along road transport infrastructure?
- Should city clusters function as ‘daily urban systems’? If so, how should the transport system be planned and operated?

## 9. REFERENCES

- Alonso, W. (1973) Urban zero population growth. *Daedalus*, 102: 191-206.
- Alpkokin, Pelin. 2012. "Historical and Critical Review of Spatial and Transport Planning in the Netherlands" *Land Use Policy* 29(3):536-547.
- Bailey, N. & I. Turok (2001) Central Scotland as a Polycentric Urban Region: Useful Planning Concept or chimera?, *Urban Studies*, 38, 697-715.
- Banerjee, T. (2009) Mega-regions or Megasprawls? Issues of Density, Urban Design and Quality Growth, in Ross. C. (ed) *Mega-regions: planning for global competitiveness*. Washington, D.C: Island Press.
- Bel G, Fageda X (2008) Getting There Fast: Globalization, Intercontinental Flights and Location of Headquarters. *Journal of Economic Geography* 8 (4): 471-495.
- Boix R, Trullen J (2007) Knowledge, networks of cities and growth in regional urban systems. *Papers in Regional Science* 86: 551-574.
- Bontje, M. (2003). A 'Planner's Paradise' Lost? Past, present and future of Dutch national urbanization policy. *European Urban and Regional Studies* 10(2) 135-151.
- Brezzi M and Veneri P (2015) Assessing Polycentric Urban Systems in the OECD: Country, Regional and Metropolitan Perspectives. *European Planning Studies*, 23(6): 1128-1145.
- Burger MJ, Meijers EJ and Van Oort FG (2014) Regional Spatial Structure and Retail Amenities in the Netherlands, *Regional Studies*, 48(12):1972-1992.
- Burger MJ, Meijers EJ, Hoogerbrugge MM and Masip Tresserra J (2015) Borrowed Size, Agglomeration Shadows and Cultural Amenities in Western Europe, *European Planning Studies*, 23(6): 1090-1109.
- Burger MJ, Meijers EJ, Van Oort FG (2014a) Multiple perspectives on functional coherence: Heterogeneity and multiplexity in the Randstad. *Tijdschrift Voor Economische En Sociale Geografie* 105 (4): 444-464.
- Burger MJ, Van der Knaap B, Wall R (2014b) Polycentricity and the multiplexity of urban networks. *European Planning Studies* 22(4): 816-840.
- Camagni, R. and Salone, C. (1993) Network Urban Structures in Northern Italy: Elements for a Theoretical Framework, *Urban Studies*, 30, pp. 1053-1064.
- Capello R (2000) The City Network Paradigm: Measuring Urban Network Externalities. *Urban Studies* 37: 1925-1945.
- Capineri, C. and Kamann, D.J.F. (1998), Synergy in Networks: Concepts, in K. Button, P. Nijkamp and H. Priemus (Eds) *Transport Networks in Europe*, pp. 35-56, Cheltenham/Northampton: Edward Elgar.
- Cervero, R. & K.L. Wu (1998) Subcentering and Commuting: Evidence from the San Francisco Bay Area, 1980-1990, *Urban Studies*, 35, 1059-1076.
- Cervero, R. (2001) Efficient urbanisation: Economic performance and the shape of the metropolis, *Urban Studies*, 38(10), 1651-1671.
- Cheshire, P. (2006) Resurgent cities, urban myths and policy hubris: what we need to know, *Urban Studies*, 43, 1231-1246.
- Cowell, M. (2010), Polycentric regions: Comparing complementarity and institutional governance in the San Francisco bay area, the Randstad and Emilia-Romagna, *Urban Studies*, 47, 945-965
- Dobkins LH, Ioannides YM (2001) Spatial interactions among U.S. cities: 1900–1990. *Regional Science and Urban Economics* 31: 701-731.
- European Commission. 2014. *EU Transport in Figures: Statistical Pocketbook 2014*. Publications Office of the European Union, Luxembourg.
- Faludi, Andreas, and Arnoud van der Valk. 1994. *Rule and Order: Dutch Planning Doctrine in the Twentieth Century*. Amsterdam: Springer.

- Halbert, L. (2004) The Decentralisation of Intrametropolitan Business Services in the Paris Region: Patterns, Interpretation, Consequences, *Economic Geography*, 80, 381-404.
- Howard, E. (1902) *Garden Cities of To-Morrow*. London.
- Johansson B, Quigley J (2004) Agglomeration and networks in spatial economies. *Papers in Regional Science* 83, 165-176.
- Kennisinstituut voor Mobiliteitsbeleid (2014) *Mobiliteitsbeeld 2014*. The Hague: KiM.
- Kloosterman, R.C. & S. Musterd (2001) The Polycentric Urban Region: Towards a Research Agenda, *Urban Studies*, 38, 623-633.
- Knaap, G.A. van der (1994) *Ruimtelijke complexen en schaalspanning op de stedenring*, EGI-onderzoekspublikatie 19. Rotterdam: Erasmus Universiteit Rotterdam.
- Krugman P (1993) On the number and location of cities, *European Economic Review*, 37(2):293-298.
- Lambooy, J. (1998) Polynucleation and economic development: the Randstad, *European Planning Studies*, 6, 457-466.
- Lee, B., & P. Gordon (2007) Urban spatial structure and economic growth in U.S. metropolitan areas. Paper read at the 46th Annual Meetings of the Western Regional Science Association, at Newport Beach, CA.
- Meijers E.J. & M. Burger (2010) Spatial Structure and Productivity in U.S. Metropolitan Areas, *Environment and Planning A*, 42, 1383-1402.
- Meijers E.J. (2008b) Summing small cities does not make a large city: Polycentric Urban Regions and the provision of Cultural, Leisure and Sports Amenities, *Urban Studies*, 45, 2323-2342.
- Meijers EJ, Hoogerbrugge MM and Burger MJ (2015) *Metropoolvorming en netwerkkracht*. In: Van Oort F, Meijers EJ, Thissen M, Hoogerbrugge M and Burger M (eds) *De Concurrentiepositie van Nederlandse Steden, van agglomeratiekracht naar netwerkkracht*. The Hague: Platform31, pp. 123-142.
- Meijers, E. (2007). Clones or Complements? The Division of Labour between the Main Cities of the Randstad, the Flemish Diamond and the RheinRuhr Area. *Regional Studies*, 41(7), 889-900.
- Meijers, E.J, Burger, M. and M. Hoogerbrugge (forthcoming) Borrowing Size in Networks of Cities: City Size, Network Connectivity and Metropolitan Functions in Europe, *Papers in Regional Science*, accepted for publication.
- Meijers, E.J. & M. Burger (forthcoming) Stretching the concept of 'borrowed size', *Urban Studies*, accepted for publication.
- Meijers, E.J. (2005) Polycentric Urban Regions and the Quest for Synergy: Is a Network of Cities More than the Sum of the Parts?, *Urban Studies*, 42(4): 765-781.
- Melo P., Graham D., & R. Noland (2009) A meta-analysis of estimates of urban agglomeration economies, *Regional Science and Urban Economics*, 39, 332-342.
- Ministry of Infrastructure and Environment. 2012. *National Structural Vision*. Report, English summary available at:
- Neal Z (2013) *The Connected City: How Networks are Shaping the Modern Metropolis*. New York: Routledge.
- OECD. 2007. *OECD Territorial Reviews: Randstad Holland, Netherlands*. OECD, Paris.
- OECD. 2013. *Environment at a Glance 2013*. OECD Indicators. OECD, Paris.
- OECD. 2014. *OECD Territorial Reviews: Netherlands*. OECD Indicators. OECD, Paris.
- Parr, J. (2004) The Polycentric Urban Region: A Closer Inspection, *Regional Studies*, 38, 231-240.
- Parr, J. (2008) Cities and regions: problems and potentials, *Environment and Planning A*, 40, 3009-3026.

- Phelps NA (1998) On the edge of something big: Edge-city economic development in Croydon, South London, *Town Planning Review*, 69(4):441-465.
- Phelps NA (2004) Clusters, dispersion and the spaces in between: For an economic geography of the banal, *Urban Studies*, 41(5-6):971-989.
- Polèse M and Shearmur R (2006) Growth and location of economic activity: The spatial dynamics of industries in Canada 1971-2001, *Growth and Change*, 37(3):362-395.
- Priemus, Hugo. 2007. "System Innovation in Spatial Development: Current Dutch Approaches." *European Planning Studies* 15(8):992-1006.
- Sassen, S. (2007) Megaregions: benefits beyond sharing trains and parking lots? in: *The Economic Geography of Megaregions*, K.S. Goldfeld (ed), Princeton, NJ: PRIOR, pp. 59-83;
- Schwanen, T., Dieleman, F.M. & M. Dijst (2004) The Impact of Metropolitan Structure on Commute Behaviour in the Netherlands: A Multilevel Approach, *Growth and Change*, 35, 304 – 333.
- Schwanen, Tim, Martin Dijst and Frans M. Dieleman. 2004. Policies for Urban Form and their Impact on Travel: The Netherlands Experience. *Urban Studies* 41(3):579-603.
- Shetter, William. 1988. *The Netherlands in Perspective: The Organization of Society and Environment*. Leiden: Martinus Nijhoff.
- Spaans, M. & Stead, D. (2015). Integrating Public Transport and Urban Development in the southern Randstad. In: Schmitt, P. & van Well, L. (eds) *Territorial Governance across Europe: Pathways, Practices and Prospects*. Routledge, London.
- Taylor P (2003) *World City Network: A Global Urban Analysis*. London: Routledge.
- Turok, I. & N. Bailey (2004) The Theory of Polynuclear Urban Regions and its Application to Central Scotland, *European Planning Studies*, 12, 371-389.
- Ullman, E. (1956) The role of transportation and the basis for interaction, in: *Man's role in changing the face of earth*, W. Thomas (ed), Chicago: The University of Chicago Press, pp. 862-880;
- United Nations. 2013. *Demographic Yearbook*. United Nations, New York.
- United Nations. 2014. *National Accounts Statistics: Analysis of Main Aggregates, 2013*. Department of Economic and Social Affairs, Statistics Division, United Nations, New York.
- Van Oort, F., Thissen, M. and M. Burger (2015) Polycentriciteit en concurrentiekracht. In: Van Oort, F., Meijers, E., Thissen, M., Hoogerbrugge, M. and M. Burger (eds) *De concurrentiepositie van Nederlandse steden*. The Hague: Platform31, pp. 65-73.
- Veneri, P. & D. Burgalassi (2012) Questioning Polycentric Development and its Effects. Issues of Definition and Measurement for the Italian NUTS-2 Regions, *European Planning Studies*, 20(6), 1017-1037.
- Veneri, P. (2010) Urban polycentricity and the costs of commuting: Evidence from Italian metropolitan areas, *Growth and Change*, 41(3), 403-429.