

# Analysing Larger Metropolitan Areas Ref 121

## On Identification Criteria for Middle Scale Networks

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### **Abstract**

*The aim of this paper is twofold. Firstly, it discusses how to analyse entire regions with the help of space syntax. Secondly, it demonstrates how a main route network through and between urban areas can be calculated in Depthmap. For this purpose one can combine angular choice with metrical distance and add various radiuses on top of each other. The Randstad area as a whole serves as an example.*

*Until recently a spatial configurative analysis of the Randstad's street and road net could be done in two ways. One of alternative required an analysis of each city, village and town separately with the help of traditional space syntax method. The other one consisted in separating the various layers of movement by drawing them manually on a map. The highway, the local street net and the main routes through cities are identified and drawn separately. Tracing the main routes manually results in two problems. One is the identification criterion for defining a street or road belonging to a main route network. Apparently, this criterion has never been singled out appropriately. Different researchers have come up with different results when tracing the main routes in the same area. The other problem touches upon the difficulty to predict economical consequences of proposed urban interventions. It is difficult to know exactly where main routes were located in the past, and it is even more difficult to know whether a new road link will function as a main route or not in the future. Hence, the method's scientific value is at stake. For it does not meet the criteria of objectivity, falsifiability, predictability and testability.*

*Recently, Depthmap has undergone large changes. In addition calculating topological distance, metric distance and angular relationships were taken into account. These kinds of measurement were applied to the Randstad in its entirety. Furthermore, experiments with these kinds of measurements allowed for an identification of the main route net (or the middle scale net) with the help of a combination of angular choice and topological distance with radius 3 and 8. This analysis does not only highlight the main routes. It also indicates the degree of vitality of the various streets and roads belonging to a main route network.*

*As the spatial analyses of the whole Randstad show, the ZuidAs in Amsterdam is the most integrated part. It explains as to why 90% of the foreign directed investment takes place in this area. For the rest, the highest integrated streets are on the most congested highways. On a local scale, Amsterdam centre has very high integration values on its street net in comparison with the Randstad's other towns and cities. In general, a city's degree of economical attractiveness in the Randstad depends on how it is connected to the highway system and to what extent its centres are accessible from the highway net.*

### **Analysing Larger Metropolitan Areas**

The name "Randstad" came into being in the 1930's from the Dutch airline's (KLM) founder Albert Plesman. During his flight over Holland in search for a location for a new airport, he saw from a

bird's eye's perspective a ring of towns and cities by coincidence located round a green open area. Since then, it became a concept in search for fulfilling the dream to make one large international Dutch metropolis.

However, does the Randstad spatially function as one metropolis? In general, one is confronted with two issues. On the one hand is how political, planning and policy issues use the term Randstad for promoting the urbanised southwestern part in the Netherlands as one metropolis. On the other hand is how the Randstad function spatially and economically as one united metropolis on various scale levels.

The Dutch research institute Ruimtelijke Planbureau has carried out several research projects on the existing economical situation seen in relationship with present and past planning policies in the Randstad. As their research show, the reality often deviates from policies documents. However, what these research projects lack, is a quantifiable spatial method for independent comparison with socio-economic data.

For some years ago a small test model was made and analysed with the help of space syntax (van Nes 2007) and the following hypotheses were proposed: A city's degree of economical attractiveness in the Randstad is dependent on how it is connected to the highway system and how highly its centres are accessible from the highway net. Hence, the spatial structure of the road and street network matters for an area's degree of attractiveness and vitality for generating economic investment.

In order to understand the utopia and reality paradox for the Randstad case, one has to reveal three kinds of forces, namely speaking the political, planning and policy forces, the marked forces and the spatial forces. These issues will be discussed in the following sections.

### **1.1 Randstad's planning forces**

The idea of enhancing the Randstad as one metropolis can be found in past and present policy documents. In the present mobility policy document, emphasis is put on developing effective national highways and the way they should support economical development and growth. Two dimensions are forgotten. One concerns the degree of inter-connectivity between national highways to regional roads and to provide local regions with an effective regional street and road net. At present vehicle transport is forced to travel on national highways, even though it is between neighbouring cities a few kilometres away from each other. A kind of "middle scale" road system through and between urban areas and regions is forgotten. The other dimension is how one should scope with the existing city centres and urban sprawl problems. If the policy is to provide an area with an infrastructure supporting economic activities, then it will support urban sprawl along highway corridors and junctions.

While the mobility policy document prioritises high accessibility in order to support economical development, few visions concerning the land use along highways are taken into account in the national Spatial Policy Document. Even though various enterprises establish themselves along highways junctions close to large cities, the spatial policy document focuses on urbanisation in existing urban areas. As the document acknowledges, a highway is more than a distributor of traffic flows. It functions also as a place where economical activities establish themselves and where urbanisation takes place (VROM, 2004, 33).

In general the various existing national policy documents are conflicting with one another. Whereas the housing policy document promotes dwellings in green urban areas, the spatial policy document propose a strategy enhancing high density in existing urban areas. Whereas the mobility policy document emphasises an effective infrastructure with high accessibility, the spatial policy document promotes intensifying existing urban areas. Seen all together, the various present policy documents opens up for to let the marked forces influence the development more than in previous policy documents, but to keep up building restrictions in the "sacred" green heart. In general, since private car ownership is a "holy" issue, not spoken out at all in present planning documents, there are sufficient gaps opening up for a car dependent suburban lifestyle and car based localisation pattern of enterprises.

In the 1990's the ABC localisation policy was made by the Dutch ministry for various types of companies and public facilities. This policy was flagged under the name "the Right Business in the Right Place" (van Huut, 1991). The implementation was partly successfully in the Hague centre. Amsterdam aimed at transforming the old dock land areas on the northern side of the central station to an A-location suitable for international and national companies. This area is highly accessible by train, but poorly accessible by car. Even though the area can be reached within 10 minutes train travel from Schiphol airport and the historical city centre is adjacent, international companies preferred the ZuidAs due to high accessibility from the ring road. It was original a C-location before the new rail line came. Now it is a typical B-location with good car and train accessibility. In contrast with the aims of the ABC location policy, many offices preferred the C-locations, due to good accessibility from highways (Hamers and Nabielek 2006, 39). Seemingly, the adjacency of a train station was not considered as important for the businesses.

Even though names, governments, and policies changed during the last 50 years, it influenced national planning policy documents and the Randstad debate for involved parties. Several times same concepts of the Randstad has been re-invented. It all depends on changes in the economy and marked forces. What is then Randstad's reality beyond its name? Does it exist at all? Or is it something between dreams and rhetorics? In this respect an insight in Randstad's marked forces might be of interest.

## **1.2 Randstad's marked forces**

In a research project from the research institute Ruimtelijke Planbureau, Hamers and Nabliek investigated how urban sprawl takes place along the highways in the Netherlands. Due to existing policy documents, national organisation's structures and division of responsibilities, the land along the highways seems to be left over to the marked forces and the municipalities' various interests for facilitating a development of this kind. The pressure on the highway junctions is highest on towns and cities' edges, or where highways tangent built environments (Hamers and Nabielek, 2006, 8 and 81).

In comparison with other European countries, the Dutch highways have a high density of junctions. Therefore, linear development along highways takes place. Often these areas tend to look messy, with a sprawl of buildings, randomly placement of advertisement signs and larger open spaces with parking possibilities. The types of large-scale detail shops in these areas are car dealers, garden shops, furniture shops, caravan shop, and leisure activities, such as sport and fun park facilities. The enterprises are defined to be large offices, companies, show rooms and storage possibilities.

The customer and the employee these enterprises aim at to serve are the car dependent ones preferring having everything easily accessible on a regional level. The customer of this kind is also supported by the location of new VINEX dwelling areas proposed in the 5th national spatial policy document. Most of them are located closer to the highway net than the old historic city centre.

Hamers and Nabielek describe the various economical forces and the lack of a unified planning policy in their research report. What is lacking is a spatial method for describing the spatial forces at the junctions on the highway seen in relationship with the towns and cities. One has to investigate as to why some highway junctions are more attractive than others for locations of enterprises. Likewise, the location along highways has to be studied together with accessibility questions in city and town centres.

In his PhD research, Roberto Rocco investigated the features of the location of international companies or foreign directed investment companies (FDI) and advanced producer services (APS). Likewise, he investigated how the urban structure simultaneously determines the location of APS and is conditioned by it, especially through the carrying out of large urban key projects (Sleutelprojecten). As his results show, almost 90% of the headquarters of selected APS and FDI companies are located along and in the vicinity of the ZuidAs in Amsterdam. Most headquarters are located around key nodes of transportation, where national and regional roads meet train stations. There is also a large concentration of firms around Amsterdam's ring road. As these

characteristics show, firms in the advanced tertiary sector of economy rely especially on good connectivity and accessibility, as well as image and visibility (Rocco and van Nes, 2005).

In another research project from Ruimtelijke Planbureau, it is demonstrated to what extent the Randstad function as one network city in terms of identifying the various municipalities' degree of complementary and speciality in relation to each other, and how integrated they are in the Randstad as a whole. The various companies' contact network, the commuting flows between homes and working places, and the shopping behaviour of Randstad's inhabitants was investigated. The concept network is used here in terms of describing the socio-economical contact network connections between companies, firms, and the inhabitants' daily movement system.

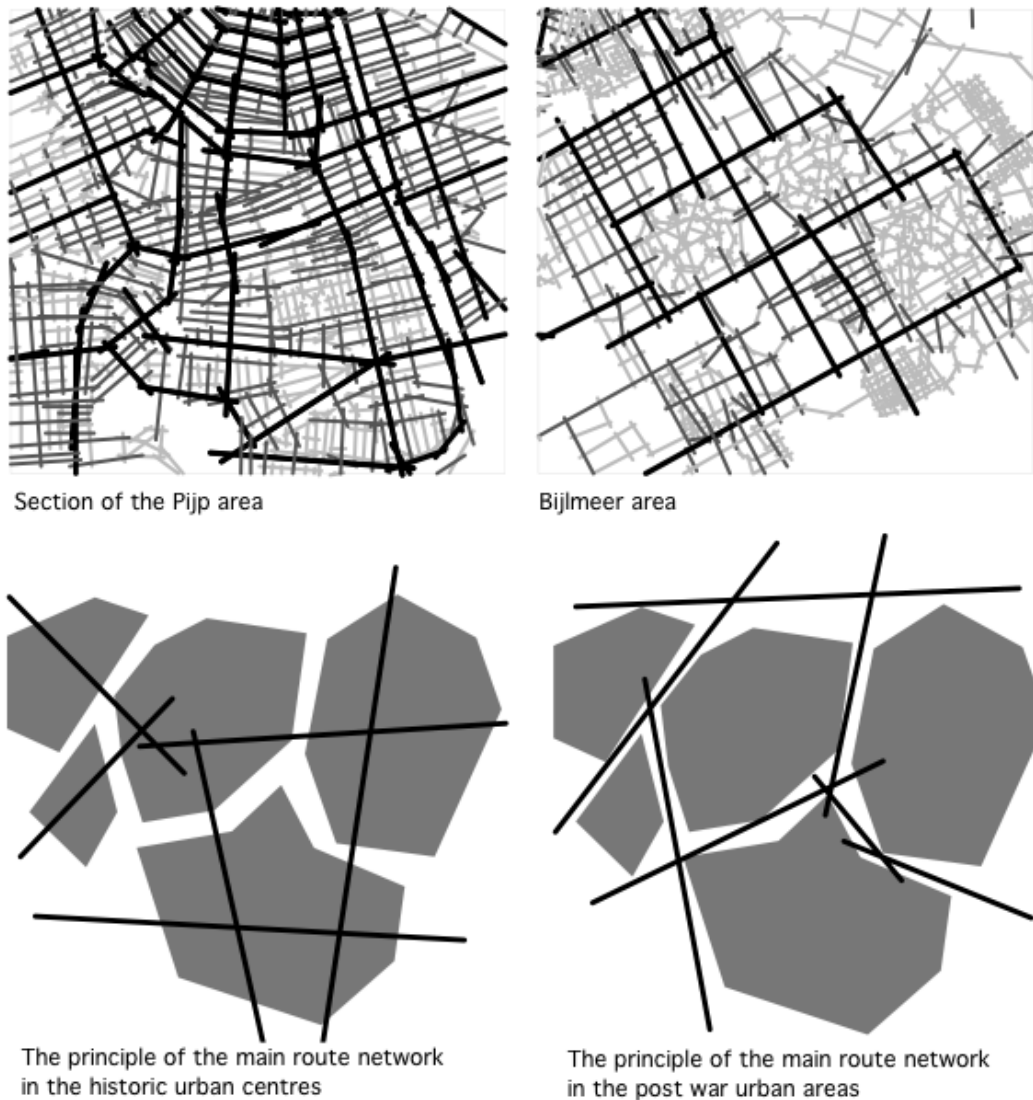
As the results show, distribution companies locate themselves in cities close to the main ports, while business and non-profit activities locate themselves in the large cities. In terms of the distribution of companies and types of shopping areas, all the cities and towns start to be alike each other during the last century in terms of population composition, composition in the companies sector structure, shops types, and degrees of specialities. Randstad's inhabitants shop in their own neighbourhood for the "run" shopping, while they travel to the closest town or city centre for the "fun" shopping (van Eck et al 2006, 120). The same distribution of shops, enterprises, public institutions and leisure activities can be found in every town and city.

As the authors state, the Randstad does not function as a network city. The distance between the towns and cities are too far for shaping this urbanised area to one metropolis. Therefore, each town and city is more or less self sufficient with the way companies, shops, public facilities, health and educational institutions, nightlife activities, cultural entertainment programs and various type leisure activities are distributed (van Eck et al 2006, 160). As concluded, the Randstad consists of a set of independently self-provided cities and towns.

In yet another research project on future shopping trends and their spatial requirements from Ruimtelijke planbureau, it is predicted that more fun shopping will take place in out of town centre mega malls than in the inner city centre areas. Already in existing spatial planning policy, the location policy decision has moved from a regional level to municipality level. The customers' demands for shopping mall with high car accessibility will make a pressure for changing existing location strategies. If one loosens up the existing Dutch restrictive location policy, pressure will increase on out of town areas. As acknowledged, shop owners search for the most optimal location in order to reach as many customers as possible and to be accessible for grocers and deliveries (Hillier et al, 1998, van Nes 2002). As Evers, van Hoorn and van Oost claim, it implies a pressure on Randstad's highway net at the towns and cities' edges, which again will imply increased car dependency (Evers et al, 2005, 291). The focus is on the conflicts between the forces from the Dutch planning restrictions, international marked forces and the demand for optimal locations. How the road and street net's spatial set up will play a role is not discussed at all in this research.

## **2. A method for analysing the Randstad's spatial forces**

From a spatial point of view, first attempts to make a spatial configurative analysis of the whole Randstad's street and road net are done in two ways. One way is to analyse each city, village and town separately with the help of the traditional space syntax method (with the Axman software), and the other way is to separate the various layers of movement by drawing them manually on a map. The second method is applied on the whole Randstad during a brainstorming Deltanet workshop in 2003 (Kusumo, van Nes and Read, 2003). The highway, the local street net and the main routes through cities (named the "middle scale network") is identified and drawn separately. The hypothesis behind this method is that cities have a kind of higher scale of movement network connecting the various urban areas together with each another and to the various city centres. Through applying a "one-step-analyses" from the main routes network one can visualise how well connected it is with the local street net in the various urban areas. As shown in figure 1, main routes tend to go "between" urban areas in post-War urban areas, whereas it tend to go "through" urban areas in post-War areas.



**Figure 1**

*A hypothesis on how the main routes are connected to local streets in traditional and post-War urban areas*

It is easily to identify the highway net and the local street net manually from most maps. However, identifying the middle scale network has so far been a rather subjective matter. It is easy to spot out the main routes in Post War urban areas from tourist maps due to their clearly hierarchic road system. It is an effect of how the Buchanan report has influenced various ways of planning streets and roads in urban areas as a consequence of the increase in private car ownership since the 1960's. As regards the main routes in Pre War built environments it could be difficult, due to the way main routes tend to be well connected and intertwined with the local street net. Therefore, as it has turned out in several student assignments analysing the same area, the results differ from individual to individual.

Tracing the main routes manually results in two problems. One is the identification criterion for defining a street or road belonging to a main route network. Apparently, this criterion has never been singled out appropriately. Different researchers have come up with different results when tracing the main routes in the same area. Moreover, one has to know the city very well in order to identify the main routes in traditional urban areas. The other problem touches upon the difficulty to predict economical consequences of proposed urban interventions. It is difficult to know exactly where main routes were located in the past, and it is even more difficult to know whether a new road link will function as a main route or not in the future. Moreover, this "layered spatial model" approach is rather ideological in the way one start to think in the hierarchical way such as proposed in the Buchanan report on how infrastructures in urban areas are built up (or rather

should be built up). Hence, the method's scientific value is at stake. For it does not meet the criteria of objectivity, falsifiability, predictability and testability.

Often the argument is used to identify the most frequented streets and road in a city for highlighting the main routes (Read and Pinilla, 2006). However, then it becomes impossible to compare it with pedestrian flow rates. One cannot build up an independent spatial methodology that is conflated with its empirical data. Often the identified main route network is compared with the location pattern of shops. Naturally, shops locate themselves where most people move. What this layered spatial model approach does is to visualise the most frequent streets, name it as a spatial approach, and compare it with pedestrian flow data and location of various economical functions. In fact, this approach makes it impossible to correlate spatial parameters with socio-economic data. When applying it into strategic urban planning, it is difficult to predict whether the results will be successful or not in order to create lively urban areas with street life and economical activities. Therefore, the model cannot be considered as a scientifically spatial analysis tool.



**Figure 2**  
*Amsterdam's main route net (top) and the dispersal of shops (below)*

However, when looking at the location pattern of shop in Amsterdam in figure 2, it is easy to identify that they follow a certain location pattern of main routes through urban areas (top). The strength of the axial analyses in the space syntax method is that it is able to compare spatial properties independently from socio-economic data. Therefore, the challenge has been the last four years to find mathematical means to calculate it only by using various spatial properties. During the last year it has become possible to identify the main routes through urban areas through the most recent development in the space syntax analyses. In the first instance, all streets and roads are represented as a set of the fewest and longest axial sight lines. No difference is made between pedestrian routes and highways. Then it is up to the mathematical calculations to identify the main routes and the lively shopping streets at various scale levels.

The latest version of the Depthmap software has the capacity to analyse the whole Randstad area. In addition to analysing topological distance, the software is also able to analyse metric and geometrical distance. The metric distance measures the city's street and road net as a system of shortest paths, while the topological distance, calculates the city's street and road net as a system of fewest turns paths. Finally, the geometrical distance gives a picture of the city's street and road net as a system of least angle change paths. Each type of relation can be calculated at different radii from each street segment, defining radius again either in terms of shortest, fewest turns or least angle paths (Hillier and Iida 2005, 557–558). The consistency of the space syntax method is to represent all Randstad's streets and roads as a set of axial lines. No differences are made between highways and footpaths in the representing of the movement network at a set of axial sightlines. After a time consuming job drawing the entirely street and road net of the whole Randstad on an axial map, the mathematical calculations do the job for highlighting the main routes from the remaining street net.



**Figure 3**  
*Global integration of the Randstad (topological distance)*

Figure 3 shows how topologically integrated a street or road in the Randstad is in relation to all others. The black colour shows the highest integrated streets while the light grey colour shows the lowest integrated ones. The highest integration values can be found on the highways, where the highest values are at the ZuidAs. During rush hours, Randstad's highways are suffering from congestion. Even though Amsterdam is metrically located on Randstad's edge, it has the topologically most central location. Leiden has the metrically most central location in the Randstad. However, topologically it has low integration values. The connection to Leiden centre is weak from the highly integrated highway A4. One has to change directions many times before the city centre is reached. The Prins Claus Plein highway junction in The Hague has high global integration values. In order to understand its vitality on a local scale, it must be seen together with a local integration analysis.



**Figure 4**

*Local integration of the Randstad (topological distance)*

Randstad's local integration analysis (figure 4) highlights the most integrated streets in the various towns and city centres. When comparing the ZuidAs with the Prins Claus Plein highway junction, the ZuidAs has both high local as well as global integration values. This explains as to why 90% of the FDI's and APS's are located in the ZuidAs. When looking at the various city centres, The Hague and Amsterdam centre have high local integration values, whereas it is low in Rotterdam. The most segregated areas in Amsterdam are in the northern suburbs and the Red Light District. In general, most post war through planned urban areas have low local integration values.

When applying the angular weighting values to the analyses, Randstad's highways are even highlighted more than in the global integration analyses. As figure 5 shows, the congested highway A13 between The Hague and Rotterdam implies high spatial integration values with angular weighting. Still the ZuidAs has the highest values. The main routes through urban areas with their degree of vitality can be found in the local angular analyses (figure 5). The highest values can be found in Amsterdam centre, the ZuidAs and The Hague centre. Otherwise, the main route system is highlighted in the remaining towns and city centres.





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**Figure 5**  
*Global angular integration of the Randstad (geometrical distance)*

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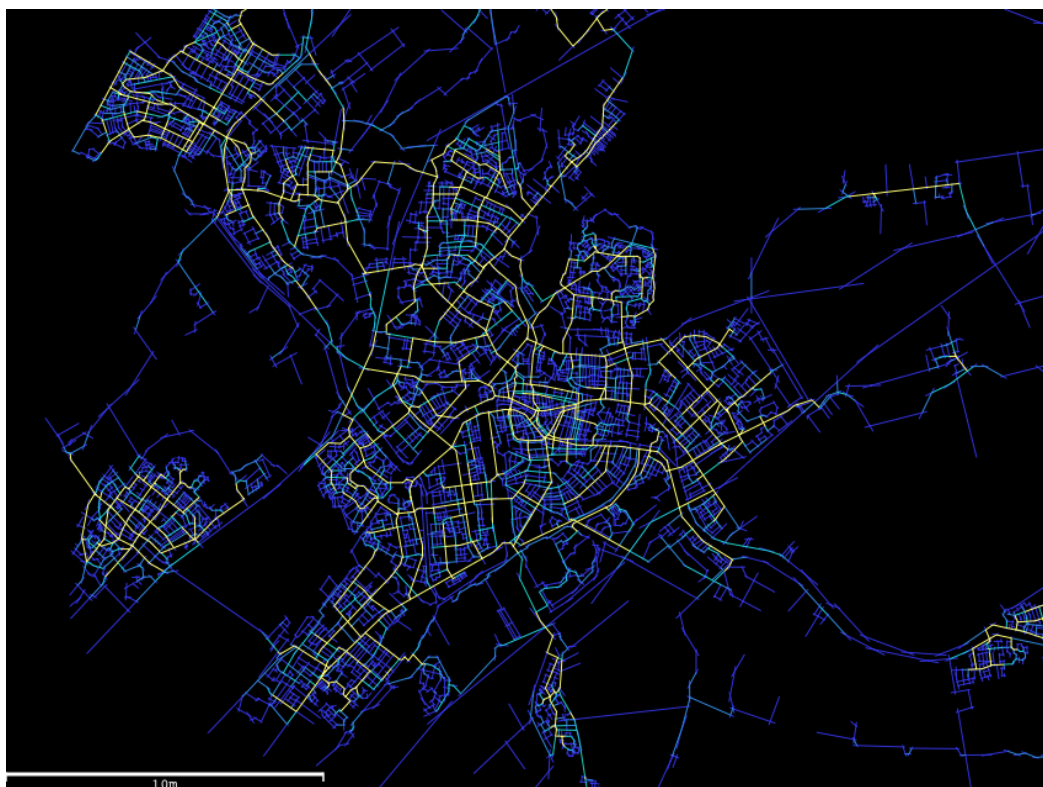
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**Figure 6**  
*Local angular integration of the Randstad (geometrical distance)*

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According to Hillier, all cities are made up of a very large number of short streets and a very small number of long streets and roads. This can be seen on all scale levels in which gives the city street networks a clearly fractal structure. The middle scale network is largely made up of longer streets or roads whose ends are linked by highly obtuse, nearly straight connections. The longer the line, the more likely it is to end with a nearly straight connection. The main routes through cities on all scale levels tend to consist of a set of longer lines connected to each other with almost 180 degree angles (Hillier et al 2007, 2-4). In this way, angular weighting contributes to highlight the main routes in the spatial axial analyses. Conversely, the local network is largely made up of shorter streets, which tend to intersect and end at a near right angle. The shorter the street, the more likely it is to end at a right angle. Most silent dwelling streets tend to be metrically short (Hillier et al 2007, 2-4).

When combining topological distance with metric distance, a correct picture of the most lively and vital streets in cities with a curved street net is given. Leiden provides an example of this kind. The two highly frequented shopping streets Harlemmerstraat and Breestraat tend not to be sufficient highlighted in the ordinary axial analyses. When correlating angular choice (geometric distance) with topological distance, it is possible to identify the local main routes in local areas and through the whole city. Various radiuses can be tried out. When adding the spatial analyses results with two different radiuses (like for example radius 3 with radius 8), the main routes network can be identified. In this way, the main route (or the middle scale) network is identified in a uniform manner. Hence, it is then possible to analyse in new urban design proposals whether a new street or road link will function as a vital main route or not. Figure 7 shows the main route net in Leiden centre. As can be seen on the figure, all main routes through and between urban areas are highlighted. Leiden has a high degree of testability due to its curved street net. Therefore, in addition to topological spatial relationships, metric distance and angular choices can be tested out.

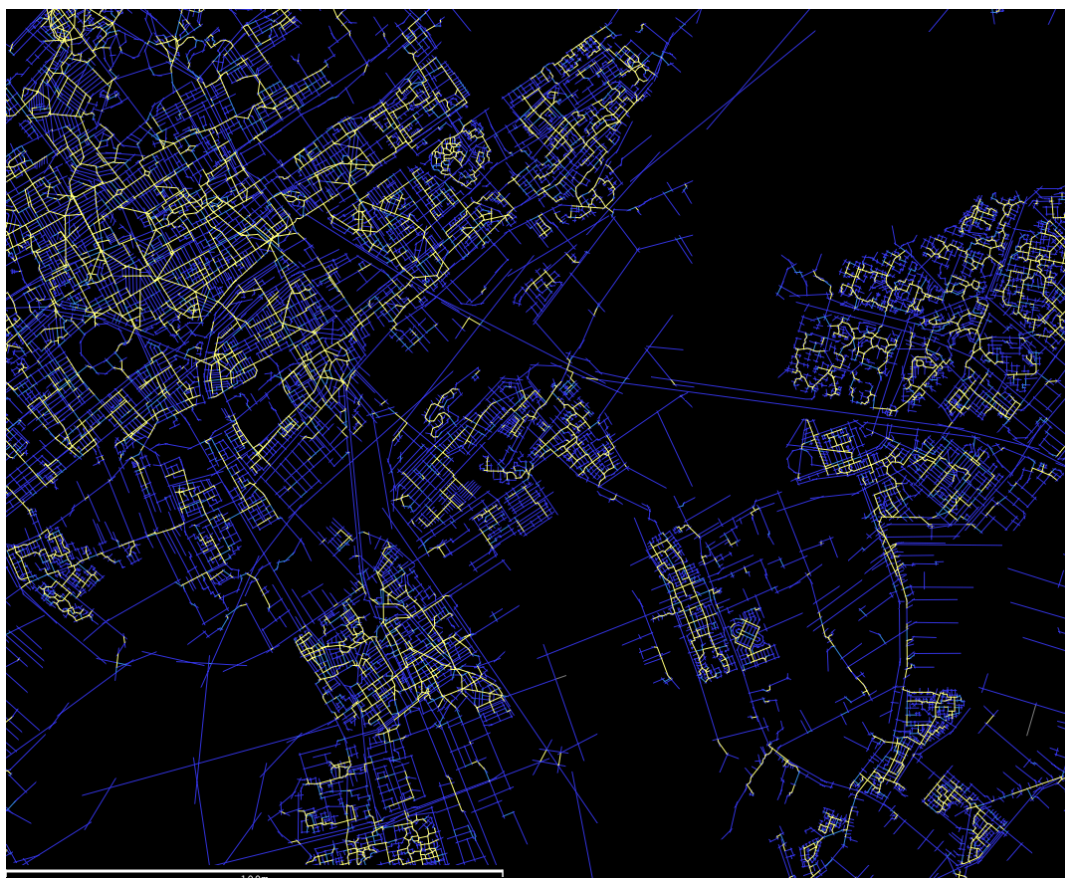


**Figure 7**

*Leiden's main route net, calculated by Depthmap*

When applying this on the whole Randstad, as shown in figure 8, the main route network in traditional urban areas tend to be clearly highlighted, while it tend to be fragmented in the modern urban areas. The more recent the urban area is, the more broken up is the main route network. In many ways,

visitors orientate themselves through urban areas by using the main route network. In particular VINEX dwelling areas are known to be difficult for way finding for visitors. When applying point depth analyses on the main route network, all local streets in traditional urban areas are accessible by changing directions 2-3 times, whereas it is accessible up to 8 steps in post-War urban areas.



**Figure 8**

*Randstad's main route net, calculated by Depthmap*

### **3. Conclusions – what space syntax adds to the Randstad debate**

The spatial configurative analyses of Randstad's street and road net shows clearly as to why the ZuidAs is a successful place for foreign directed investment. It is not only the strong image of Amsterdam and its high accessibility to Schiphol Airport. It is also spatially supported in the way there is a synergy between high spatial global and local integration. Therefore, VROM's ABC location policy from the beginning of the 1990's failed in the promotion of making the areas around the Amsterdam Central station as an A-location.

Seemingly, where there is a synergy between high spatial local and global integration it generates vital economic centres attractive for investments. So far, the Dutch spatial planning tradition during the last 50 years with its implemented "tree-structured" shaped or hierarchical infrastructure proposals has contributed to break up the natural synergy between the networks' local and global scales. Often new towns and VINEX suburban areas are very spatially segregated on a local as well as on a global level. These spatial aspects seem to be essential for creating vital urban areas. It is dependent on how the main route network through urban areas connects local streets or makes them accessible to the whole city. Hence, the degree of spatial integration of the main route network gives indication on the degree of synergy between local and global integration.

In general, the spatial analyses of the Randstad can shed some light on the centre-periphery discussion. Existing town centres are mostly conceived as the most central areas, while areas at

the city or town's edges are named peripheries. However, from a spatial configurative point of view, building new infrastructures and connecting cities to new infrastructures affect centralities on various scale levels. The results from Randstad's space syntax analyses correspond clearly with Hamers and Nabielek's research results. Namely, Randstad's highway net is the most accessible, visible and global central location in the Randstad for the location of enterprises. Moreover, if present national policy documents' vision is to shift from spatial planning to spatial development and to decentralise responsibilities from national level to local level, then new economical centres in the Randstad will emerge along the highways. As present, Randstad's central core is spatially along its highways, while its various local centres are along the well-connected main routes going through urban areas in the traditional urban areas.

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