reviewed paper

Competition between Cities and Regions in Europe – Can Smart Spatial Planning Interact with Gravitational Site Location Models for External Investment?

Jan Zaman

(Jan Zaman, spatial planner, Flemish regional Government, Spatial Development department, K. Albert II-laan 19, 1210 Bruxelles, jan.zaman@rwo.vlaanderen.be)

1 ABSTRACT

However smart a city or a region might be, a wide range of companies (eg in retail and services) use a gravitational model for site location for new investments. If the primary choice model is a gravitational one, being smart will only matter for site location within a region. From a spatial planning point of view, the right question is *'can we influence gravitational site location choice while applying intelligent and consistent long term planning?'*.

First we implement a multi-scalar gravitational analysis of the EU-28 area, allowing to define a gravitational central area. We use the population density dataset (inhabitants per hectare calculated from Corine Land Cover 2006) provided by the European Environmental Agency and Joint Research Center. Spatial statistics allow us to define areas that have significantly more inhabitants and are thus 'gravitational centers'. By applying different influence ranges, we get four different perceptions of centrality. With an influence distance of 100km we see the *european core area,* while on the opposite end a 10km distance gives us a wide range of *central places for services of proximity*. This provides every city or region with insight in the way the gravitational choice model influences investment in regions. For spatial planning, it is almost impossible to influence this with traditional planning instruments. Competition between regions and states on the European level is mostly defined by national (tax) policy and cultural differences.

In a second part, we take a closer look at the regional level. For an equal area around (1) Brussels, (2) Milano-Venezia, and (3) Wien-Bratislava we apply the same spatial statistics calculations with different influence zones. The analysis on a regional level shows clear differences in regional development and in the position of cities within the region. For the Flemish region we confront the pattern of central areas with the statistical analysis of the actual location of firms.

2 INTRODUCTION

In my professional planning experience I worked for several years as a regional planner on the Brussels Metropolitan area, more specific on the Flemish territory surrounding the Brussels Capital Region. Even if there are huge demographic challenges, unemployment and environmental pressure, the only spatial issues that were (and still are) high on the political agenda and much discussed in national media, are large retail developments and car oriented infrastructure. However, during informal discussions with a shopping mall developper, it became clear that car accessibility only comes second to the number of potential clients. The initial location choice thus appears to be a large area, based on a gravitational model. Within this chosen area, other location characteristics are studied, mainly accessibility, land availability, location of competitors and real estate price.

Remarkably, in the Flemish planning practice, we do not have a way to define high potential areas if gravitational firm location models are used. In practice this means that comparison of potential sites (eg in strategic environmental assessments), does not meet the expectations of the company looking for a new site, namely to have the same (number of) potential customers.

In this paper a generic approach to this gravitational model is used, starting from a EU-28 dataset. This approach is used EU-wide and on 3 specific regions, using the same type of calculations with different parameters. For the EU-wide maps, a short reflection tackles the question if this type of maps can be used beyond the analytical value and be incorporated in territorial policies. The regional approach is discussed from a graphical overlay of the results and complemented with planning practice experience in the Brussels periphery: What do the maps show? Is it the same on different levels? How do some maps correspond to other site location parameters eg accessibility and land price? What is the relationship between the percieved patterns and the policy goal of polycentric development?

3 DATA AND CALCULATION

3.1 Population density disaggregated with Corine land cover 2000

The raster data on population density using Corine Land Cover 2000 inventory, as produced by EEA and JRC was used as a starting point. Even if this dataset is based on statistics and land cover data that is 14 years old, it still remains the most reliable source of cross border high resolution population data. Most interesting is the fact that it is closely linked to effective land use on a 1 hectare resolution. It also allows reliable comparisons across the EU28 on the spatial distribution of population.

The grid main characteristics are:

- Geographic coverage: EU27 + Croatia. Some islands and overseas territories missing. Resolution: 100m (1 ha pixels)
- Values correspond to density in inhabitants/km2. to obtain the estimated population in a polygon, divide the sum of pixel values by 100.
- Projection: Lambert-Azimuthal equal area (INSPIRE-recommended)
- ownloadable from http://dataservice.eea.europa.eu/dataservice/ or by request from Javier.gallego@jrc.ec.europa.eu

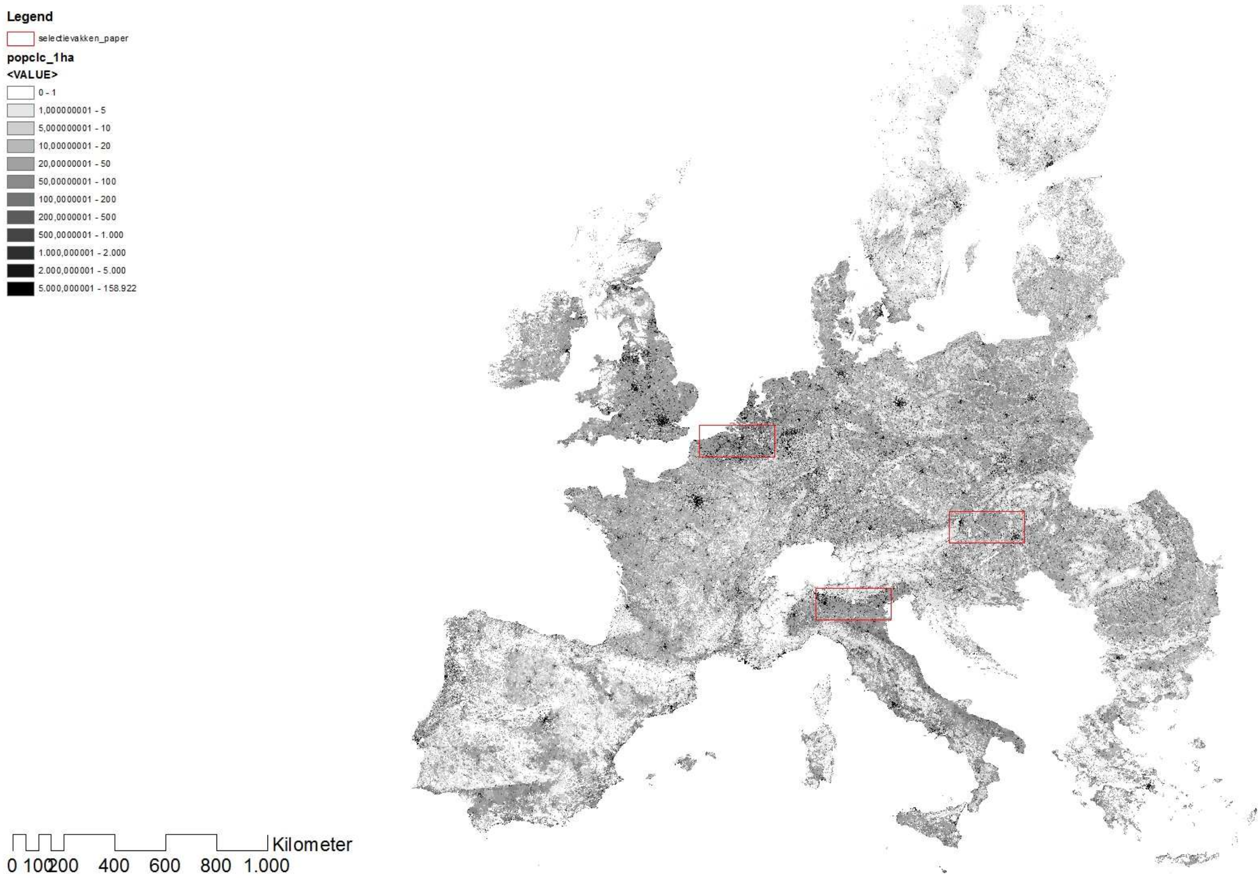

Fig. 1: Population density in EU28. EEA & JRC 2009, with indication of 3 case areas.

3.2 Hot Spot Analysis: Getis-Ord Gi*

The Getis-Ord Gi* method is used for local statistics. To do so the EEA raster dataset is first converted into a point feature dataset. Each 100mx100m pixel is turned into a point with the same value. The complete EEA dataset is too large to work with, we either aggregate the data in 5km x 5km squares, or we work with a smaller case area.

3.2.1 Calculation

The Hot Spot Analysis tool calculates the Getis-Ord Gi* statistic for each feature in a dataset. The resultant Z score tells you where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighboring features. A feature with a high value is interesting, but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbors is compared proportionally to the sum of all features; when the local sum is much different than the expected local sum, and that difference is too large to be the result of random chance, a statistically significant Z score results.

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{X}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{\left[n\sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2\right]}{n-1}}} \quad (1)$$

where x_j is the attribute value for feature j, $w_{i,j}$ is the spatial weight between feature i and j, n is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^{n} x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - (\bar{X})^2} \quad (3)$$

The G_i^* statistic is a z-score so no further calculations are required.

Fig. 2: Calculations of de Getis-Ord Gi* statistic. http://resources.esri.com/help.

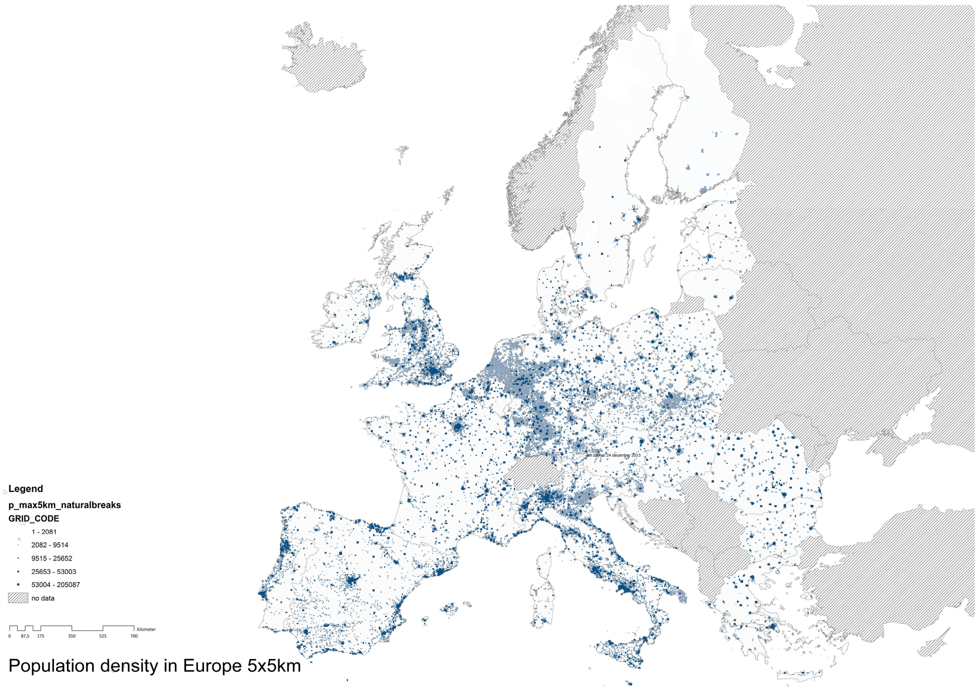

Fig. 3: aggregated population density in EU28. Maximum value appearing in each 5x5km cell.

3.2.2 Interpretation

The Gi* statistic returned for each feature in the dataset is a Z score. For statistically significant positive Z scores, the larger the Z score is, the more intense the clustering of high values (hot spot). For statistically

ISBN: 978-3-9503110-6-8 (CD-ROM); ISBN: 978-3-9503110-7-5 (Print)
Editors: Manfred SCHRENK, Vasily V. POPOVICH, Peter ZEILE, Pietro ELISEI

significant negative Z scores, the smaller the Z score is, the more intense the clustering of low values (cold spot).

4 ANALYSIS

4.1 EU28

For the complete EEA dataset, values are first aggregated in 5km squares to enable desktop calculations. In this aggregation, we chose not to work with the mean value of all cells, but with the maximum value (Fig.3). This is done to avoid the 'flattening' of the data. The results for the hotspot analysis are much clearer when using the maxima.

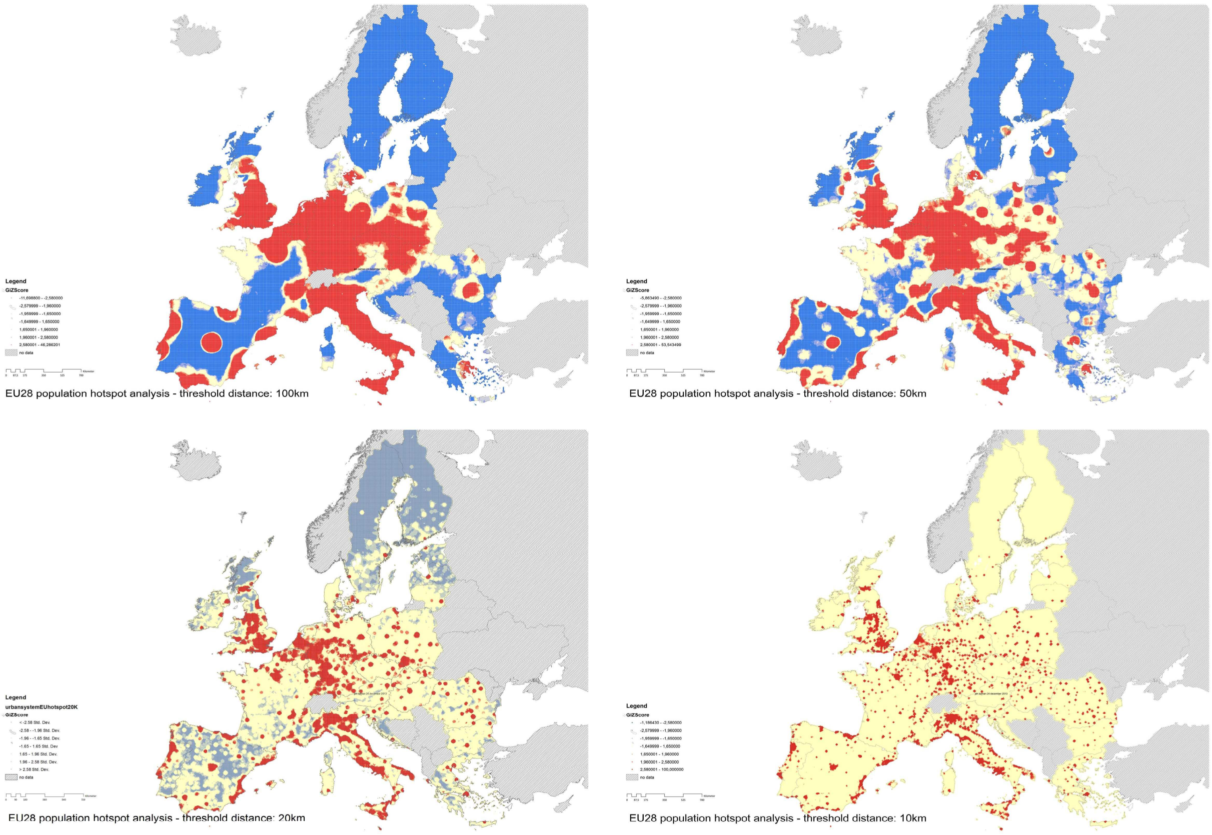

Fig. 4: Hot spot analysis on aggregated population density in EU28. Fixed distance method, 100km, 50km, 20km, 10km influence zone.

The Getis-Ord Gi* statistic is run four times, each with a different fixed distance (Fig 4.). When the influence zone is 100km or 50km we get a general image, which corresponds with how companies might look at Europe from another continent. A large (red) core area is visible, with large periferal zones (in blue) in northern, eastern and southern Europe.

If we further reduce the influence distance, we get a more detailed image on population density. At the same time, the significantly low density areas (dark blue) disappear from the map. This means that for the EU28-level, there are no areas with significantly low results for this local statistic. The mean value is so low, that all 'low' values are within 1,65 standard deviation.

Another interpretation is that the 100km and 50km hot spot analyses give a view on remoteness of some areas in Europe. The dark blue points have no larger cities within the fixed distance.

Besides stating the obvious differences in EU-28, can we use these in regional planning? In my opinion, the harmonized raster data is useful to do benchmark studies and cross-border comparisons between regions. But the link to real spatial patterns gets lost by aggregating the data to a 5x5km pixel. The fact that the dataset is already outdated and no evolution in time is provided, limits the usuability. The same analysis would probably give better results when using data on LAU2-level, with the possibility of mapping evolutions in time. However, obtaining homogenized population data on all EU28 states might prove difficult, as described in ESPON 'Territorial Performance Monitoring'.

4.2 3 Cases

For three cases (Flanders, Wien-Bratislava-Budapest, Milano-Venezia) we selected a sample area. All areas are the same size and have following characteristics (see table 1). On every territory we perform the same 3 hotspot analyses, again with fixed distances, but now 1, 2 and 5 kilometer. Larger or smaller distances do not produce a usefull map. Where Flanders and Milano have comparable statistical values, Wien is clearly different, mainly because of lower total population and lower maximum value.

	Wien-Bratislava-Budapest	Milano-Venezia	Flanders
Number of points	3.700.000	3.529.352	3.215.645
Minimum value	0	0	0
Maximum value	38.000	58.792	48.036
Sum	790.000.000	1.321.720.072	1.501.758.548
Mean	210	374	467
Median	21	36	45
Standard Deviation	1100	1356	1247
Estimated total population	7,9 million	13,2 million	15,0 million

Table 1: Key statistical data of three case areas.

4.2.1 Hotspot analyses

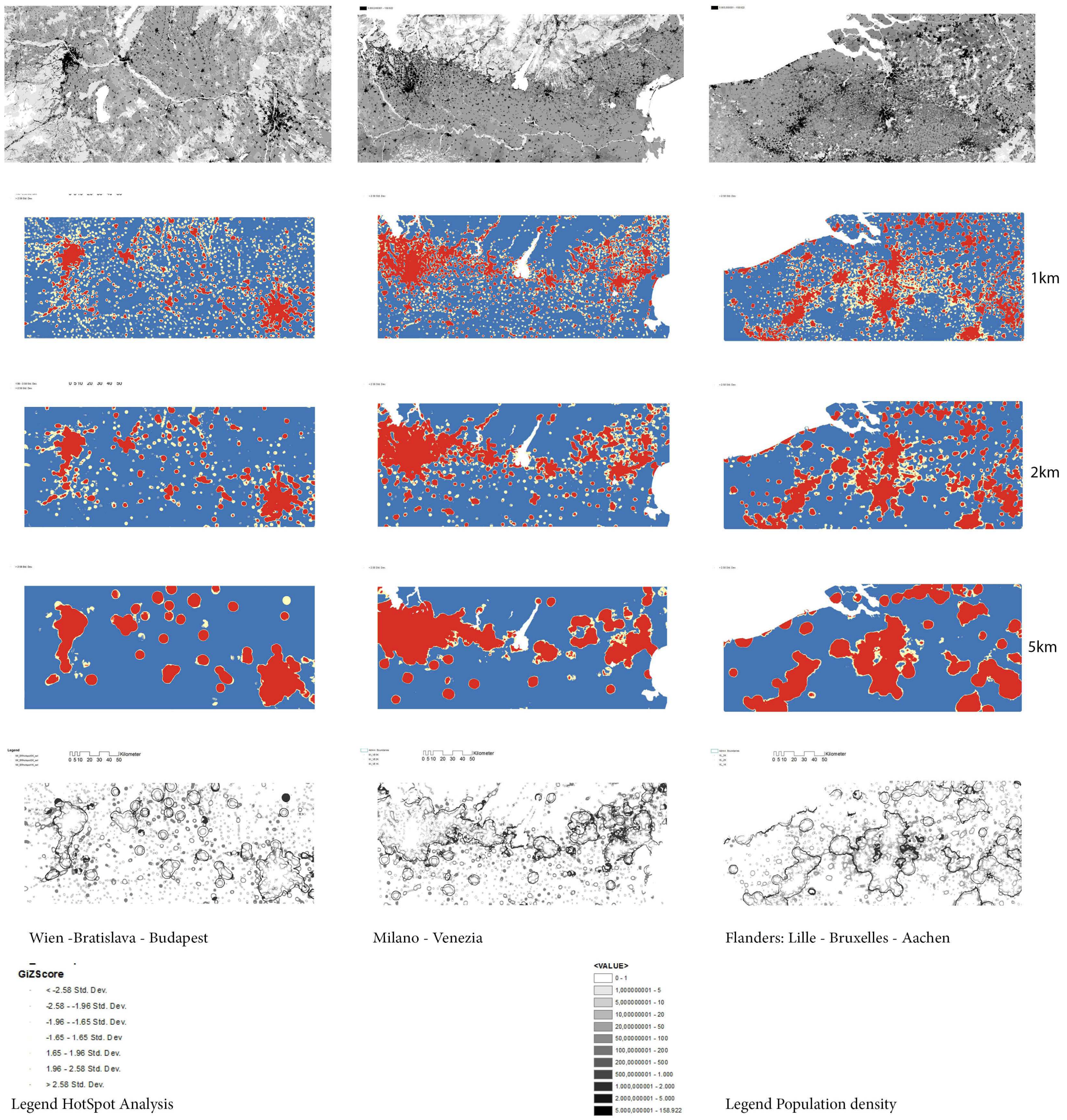

Fig. 5: Hot spot analysis on population density in three cases (Wien-Bratislava-Budapest, Milano-Venezia, Flanders). Fixed distance method, 5km, 2km, 1km influence

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Almost all point get values that are either significantly high or low. For each territory we get a multiscalar approach on the existing population density, which can be useful when assessing if a hierarchy of cities might be a realistic planning policy. However, by superimposing all three analysis, we get them together in one map.

4.2.2 3 patterns

This combined map shows us how different gravitational site location models might interact and which areas will be developed. Personal experience in the Brussels area shows that the black rings coincide with the zones where regional retail investments might locate. Grey delineations are situated around cities with a local service area (eg hospitals, schools, supermarket,...) where the light grey lines are more congruent with changes in real estate prices. In the southern Milano example, (Fig.6) we perceive three types of patterns, which are also visible in the Flanders en Wien-Bratislava maps. The first (1) is a Chistaller-like pattern of cental places, where the more important cities have 3 concentric rings. For regional investment, the area immediately surrounding the city is equally interesting as the more central areas. If the area surrounding the city has fair accessibility and low land prices, this is where development will take place and urban sprawl or ribbon development might be the spatial result.

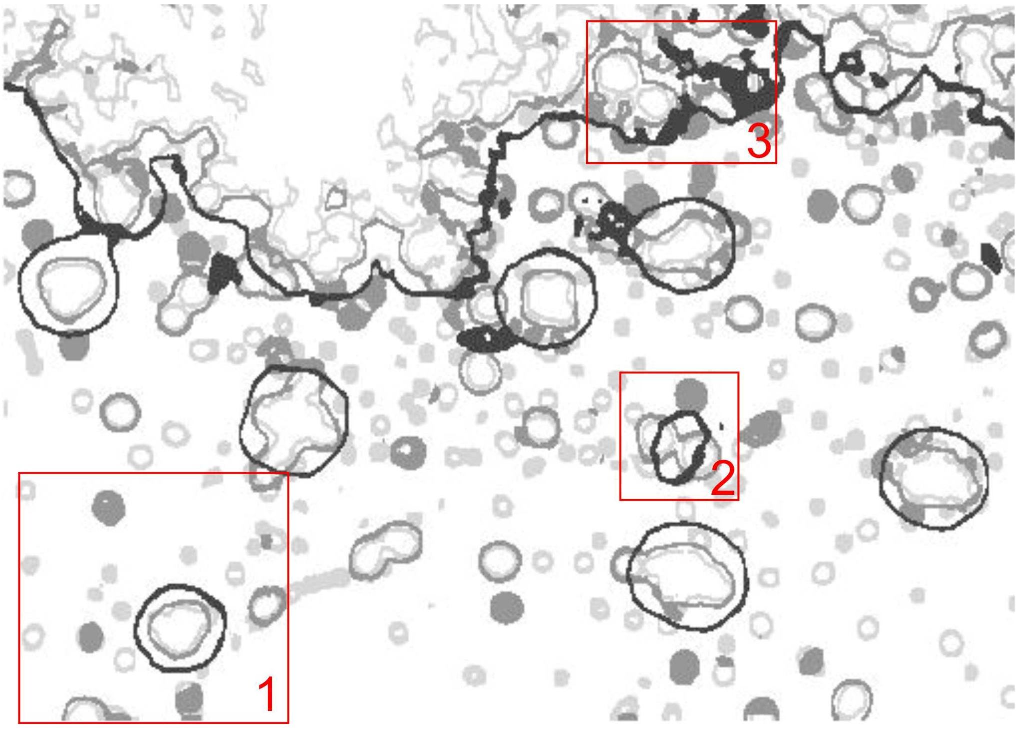

Fig. 6: Overlay of three analysis in one map of southern Milano: (1) Christaller like patterns, (2) a 'twin city' north of Piacenza, (3) 'edge city' development

In the second example, two small cities north of Piacenza are so close that the area of regional interest (black ring) is not one of the cities, but the area between them. This situation is even more difficult to handle. The third example shows an 'edge city' condition south of Bergamo, where all three types of edges (black, grey, light grey) are intertwined.

5 CONCLUSION: ROLE OF PLANNING?

Given the diversity of spatial patters, even in rather small regions, how can spatial planning interact in a such a way that it produces the type of places that are desired in policies, instead of creating the same sprawl everywhere? In the ESPON 'TRACC' project (Transport Accessibility at Regional/Local Scale and Patterns in Europe), Spiekermann and Wegener show the relationship between economies of scale, transport costs and spatial development. 'The economic geography explains regional economic development as the result of the interplay between agglomeration forces (economies of scale) and spatial interaction costs as illustrated by the vertical and horizontal dimensions of the diagram in Figure 7. The theory suggests that the prevailing historical trend of increasing economies of scale and decreasing transport costs has led from isolated dispersed settlements to an ever more polarised spatial structure with a small number of dominant agglomerations (the white arrows in the diagram). If a more balanced polycentric spatial structure is a political objective, either the trend towards increasing economies of scale or the trend towards ever lower transport costs needs to be stopped or even reversed (the solid arrows in the diagram)'. (ESPON & Spiekermann & Wegener, Urban and Regional Research (S&W), 2011, p 53)

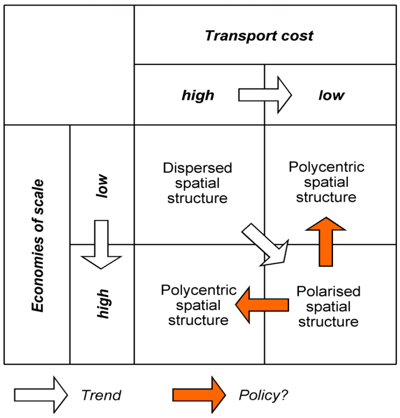

Fig. 7: Economies of scale and transport cost, as found in ESPON & Spiekermann & Wegener, Urban and Regional Research (S&W), 2011, p 53.

On the regional level, the overlay analysis shows that if a polycentric pattern is a political ambition, the territorial strategies and governance will have to be different for all three example areas (Fig 6.). In Flanders the new spatial policy plan aims to enhance the existing polycentric structure and to govern the territory is such a way that municipalities, provinces and regions work together instead of competing.

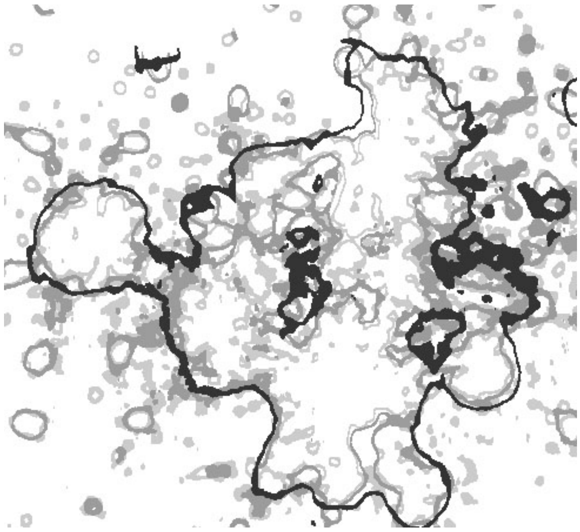

Fig. 8: Overlay of three analysis in one map of central Belgium and Flanders

Understanding how the gravitational model works, and which areas it will promote, is just a first step towards a new type of regional planning where a specific framework provides an adequate policy for different situations. More specific, the overall edge-of-city condition in Flanders and central Belgium will require innovative instruments and a long term political framework to result in a real-life polycentric urban region.

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