TECHNICAL REPORT

ESPON

Local & regional data

Producing innovative indicators at local scale

MAIN RESULTS

- Local data can be integrated from different sources or it can be produced using the LAU2 as elementary spatial patterns
- Using an appropriate number of LAU2, the data can be mobilized in specific geographical models (the estimated GDP 2006 distribution at local scale)
- The distances calculated at local scale represent an useful analysis tool which can provide new territorial indicators

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Introduction

There are four major issues to explore in this technical report. The first two are related to the construction of basic indicators, at LAU2 scale, indicators that are capable to describe and better shape specific geographical trends, such as the demographic evolution for 5 selected countries in the ESPON space. The last two parts explore the methodological problems induced by the elaboration of more complicated indicators and variables, especially in the context of a large number of spatial units. In the first part, the annexes focus on the description of a set of variables that relate the land use problematic to the local geometries. In a second part, the annexes will present some methodological aspects linked to the estimation of the local economic performance at LAU2 level, for all the ESPON space.

Intersecting specific techniques of spatial analysis with the problems raised by the management of the LAU2 geometry is another aspect present in the elaboration of this report. The questions of accessibility, the definition of spatial patterns at local level and mapping the territorial relations between these spatial patterns occupied a large part of our methodological exploration.

In a first logic, this report was conceived as a handbook of good practices and specific issues related to the LAU2 scale of analysis. However, the geographic complexity of the main studied area (Bulgaria, Czech Republic, Hungary, Romania, Slovakia) attenuates this first intention. As a matter of fact, our option for these 5 countries represents a compromise between the continuation of the first explorations in the work for this challenge and the need of a representative space for methodological experimentation (a sufficiently large number of LAU2).

1 The production of basic indicators, using the LAU2 geometries and data.

1.1 The data harmonization at LAU2 scale is depending on the spatial harmonization of the geometries for the selected countries.

Our intention is to describe by a map the demographic evolutions at LAU2 scale for the selected countries, between 2001 and 2006. This intention is based on the presence of harmonized data concerning the number of inhabitants for the two years. If the data is ready to use, the spatial frame (LAU2 geometries) is a major issue. If in 2001 some of the capitals were presented as a single polygon, in 2006 their administrative territory is divided (Budapest more than 20 LAU2, Bratislava more than 15, Bucarest 6 sectors). It isn't a major issue, as a matter of fact the aggregation of data is just a time problem. Other LAU2 are more concerning. Some of them have disappeared during 2001-2006, some others just appeared on the map, without necessary having a connection between the two categories. The logical way to deal with the spatial lack of harmonization is to exclude them from the analysis. This option becomes illogical when the administrative mutations in the local geometry become too important. In that case, it is recommended to apply various techniques that can finally harmonize these spatial dynamics.

1.2 Working with a large number of LAU2 units involves accepting the extraordinary values.

The issue of the extraordinary values is induced by the large number of spatial units with almost insignificant population (in Bulgaria we deal with municipalities that used to have 10 inhabitants in 2001). In this LAU2, every change in the population will transmit "considerable" evolutions when we map relative indicators, such as the variation of population for the mentioned period. The same phenomena can be observed for some LAU2 that are situated in the proximity of large cities, involved in processes of sub-urbanization. As a matter of fact, the extraordinary values are not extra-ordinary at all, if one would look at the local context in which the demographic trends are deployed. Usually, these values are consistent with the regional evolutions that shape the demographic decline or growth, the positive spatial auto-correlation being a general rule. One special case of extraordinary value appears in areas with administrative mutations. If one LAU2 suffered an administrative division/split, it will create a "fake" extraordinary value that reflects the creation of a new LAU2 rather than a demographic evolution.

Administrative mutations and extraordinary values

There are many cases of administrative mutations that can influence the mapping process. One of the most common issue is the territorial division, from one LAU2 resulting 2 new spatial units. We cannot correctly estimate the demographic evolution, in this case, for obvious reasons. Sometimes is not the division of LAU that becomes a problem. The administrative union of two LAU also interferes with the data calculation, even for simple indicators like the evolution of population. We can find even more complicated cases where the division is followed by a union, involving massing data or extraordinary values for three LAU. Occurring very often in Romania and Bulgaria, these mutations are reflecting the importance of the local dimension in the political and administrative strategies. We can observe on the map that these changes in the basic geometry are correlated with the economic territorial rhythms. Thus, in some less dynamic regions, the fragmentation indicates the stake of the public administrative finance at local scale, while in the pro-active regions we can interpret it as a trend to concentrate the local financial resources (the proximity of cities, touristic regions, rich industrial and transportation corridors).

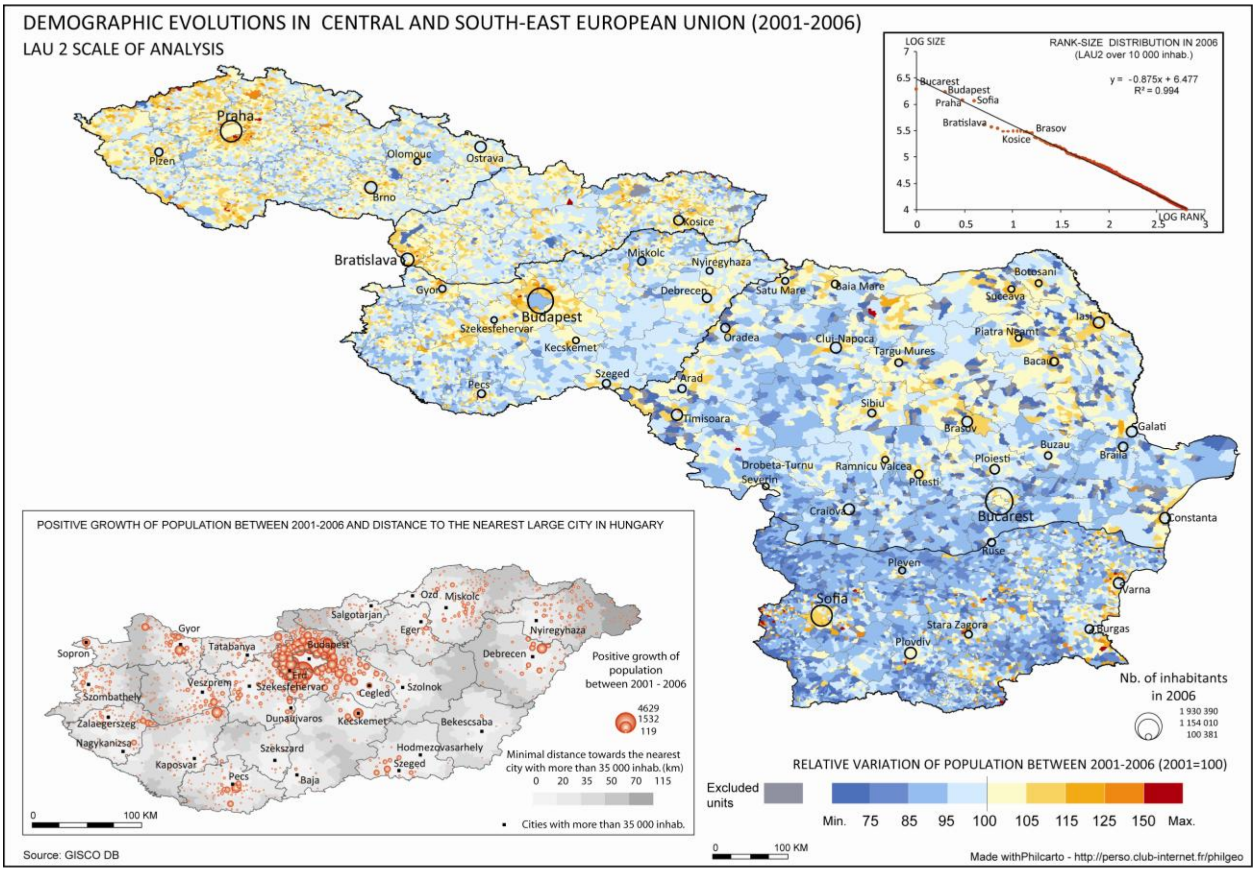

Figure 1 Trends of demographic evolution in 5 selected countries of the ESPON space (draft map)

1.3 Mapping the evolution(s) in connection with some explanatory factors.

Despite the spatial fragmentation and the lack of coherence regarding the LAU2 geometry of the 5 countries, some general trends can be easily identified. The positive demographic evolution is a function of some qualitative and quantitative transformations that reshape the role of the large cities in the territory: sub-urbanization and metropolitan development. However, defining the large city in the area of the selected countries is not an easy task. The rank size distribution for 2006 indicates that a possible superior limit should be 280 000 inhabitants (an approximation). Many cities below this limit are also involved in the suburbanization process, reflecting their key position in the national urban system and also their economic strength. Sometimes, the demographic growth is controlled by the distance towards the nearest city, such is the case in Hungary – extremely visible for Budapest, but also for Pecs, Szeged or Debrecen. On the other side, some rural regions (with a traditional pro-natalist behavior) like Moldavia (Romania) or Haskovo-Kardzali region (Bulgaria) still conserve positive evolution. Other recent studies emphasized that this natalist behavior is in extinction. A special case is the Central-Transylvania where the final phase of the demographic transition was conjecturally interrupted by some ethnic and confessional local specificity. The demographic decline is a challenging reality for vast rural spaces in Bulgaria, Romania and Hungary, but also regionally present in Czech Republic and Slovakia. Taking into account the surface concerned by this phenomena - the cross-border Danubian region between Romania and Bulgaria or the cross-border region between Romania and Hungary, this decline could represent a policy relevant aspect regarding the demographic evolutions in the ESPON space.

1.4 Explaining the demographic decline: some basic hypothesis (the spatial auto-correlation).

The distribution of the three dimensions of the demographic evolution (stability, decline and growth) present a specific spatial pattern. As a general rule, the LAU2 characterized by decline seem to have neighbors presenting the same trend. In the proximity of the cities, the LAU2 positive evolution is also included in a locally homogeneous context. The area of relative demographic stability is also subject to similarity with the neighbors (this area is visible in the Romanian Sub-Carpathians). This effect is called spatial auto-correlation and it is largely developed and formalized in the geographic litterature. There are many ways in which we can test its existence (Geary test, Moran’s I or the measure of the local dissimilarity). In our case, testing the presence of the spatial auto-correlation in the demographic evolution is a good method to estimate the relationship between the indicator and the local context. Basically, we try to estimate the size of a homogeneous region that is characterized by the same demographic trend, at local scale. That is the sens of the word “explaining” in the title of this fragment. Technically, we have to follow several steps in order to obtain the size of a homogeneous region:

1) Choose a method: testing the spatial auto-correlation using a GIS is a simple task. In the absence of a GIS, there is a spreadsheet method that involves the manipulation of a large table of geographic information.
2) Depending on the method, reflecting on the concept of neighborhood is also useful. At local scale, the administrative contiguity is problematic because we have to take into account the spatial fragmentation (e.g. administrative contiguity is problematic in Bulgaria, exaggerated in Romania, just good in Hungary). A distance bandwidth will be a better option in order to define the neighbors and the proximity effect.
3) Three hypothesis are now available for testing :
   H0: the spatial auto-correlation is null. Any two neighbor LAU are neither similar, neither different to any two LAU that are not neighborhood related.

H1: the spatial auto-correlation is negative. Two neighbors LAU are less similar than two distanced LAU. The local context is characterized by heterogeneity.

H2: **the spatial auto-correlation is positive**. Two neighbors LAU are rather similar compared with two distanced LAU. The local contexte is characterized by homogeneity.

4) If the test confirms the **H2,** by enlarging the neighborhood context we can obtain the size of a locally homogeneous region in relation with the demographic evolution. For more details, see http://grasland.script.univ-paris-diderot.fr/

In our case study, we have made an option for the GIS solution because using a spreadsheet method will involve the manipulation of 20 000 by 20 000 matrix, which is a time consuming strategy, difficult to implement. The test of spatial autocorrelation (Moran's I) confirms the **H2** hypothesis (0.145 in a range of 15 km around each LAU2 in the 5 selected countries, statistically representative for more than 20 000 LAU2) and shows that the local context and the demographic trends are related. In this case, we have proceeded to the development of the point 4 (see above). Despite our effort, we cannot provide the size of the homogeneous regions having the same demographic pattern for all the countries included in our study. Therefore, we have applied the test of spatial autocorrelation at different distance bands only for Hungary and Romania. The general trend of the Morans's I distribution for the two countries shows a decrease of the local context's effect when we extend the definition of the "local" from 5 to 50 km. For Hungary the test was started at 5 km and then incremented by 2 km. In the Romanian case, to avoid data exclusion, the spatial auto-correlation was measured at 10 km and incremented by 5 km, until the 50 km limit was reached. The analysis of the Moran's I distribution pattern shows that the local effects diminish gradually, a clear limit for regions with similar behavior being difficult to estimate.

Hungary and Romania

The general aspect of the Moran's I distribution indicates that the auto-correlation effect decrease almost as a power function of distance in both cases. The low values of the indicator of spatial auto-correlation define an ambiguous relation between the local context and the demographic trends. With more than 3000 spatial units for each country, even these low values are representative. A better illustration of this local effect could be emphasized by using a map of the spatial distribution of the local dissimilarities. Applied for Hungary, this kind of map is an exploration tool (not very sophisticated), showing some of the local sensitivities.

Reading a similarity/dissimilarity map is not an easy task. Rather than showing the spatial repartition of a phenomena (demographic dynamics), it shows how the spatial units are acting in relation with their local context (15 km in this case), regardless of the trend – decline, stability, growth. The positive values in the legend indicate local homogeneity, while the negative ones a different behavior compared with the neighborhood. The color's graduation shows the intensity of the homogeneity vs. heterogeneity spatial distribution concerning the demographic evolution in Hungary. In a context of general decline of population, a large part of the Hungarian territory is behaving spatially auto-correlated. As a map description, the heterogeneous areas are situated near the large Hungarian cities and in the proximity of the "triplum confinium" of some of the NUTS 3. The homogeneous zones are occupying the central and the eastern parts of Hungary and this moderate lack of dissimilarities should also be linked to the size of the LAU2 in these regions. This map is the output of a double interrogation in a similarity matrix weighted by distances, a map that involved the manipulation of more than 3000 rows and columns. However, this method (even if time consuming) provides a good tool in order to better interpret the spatial repartition of the demographic dynamics and could be particularly useful in studies concerning the cross-border regions.

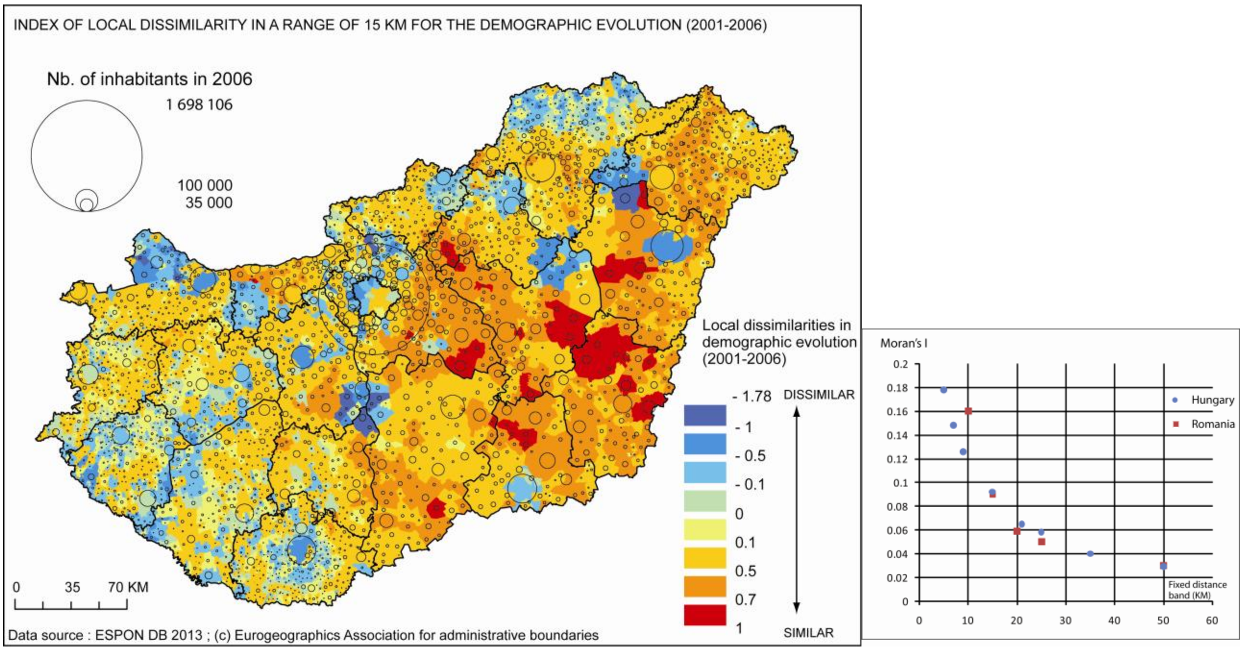

Figure 2 *Distribution of Moran's I as a distance decay function in Hungary and Romania*

2 The production of some basic indicators, using the LAU2 geometries as a geographic objects. Spatial patterns vs. spatial structures.

2.1 A short introduction in the spatial patterns: points, polygons, lines and networks. The LAU2 as spatial patterns.

We like it or not, the geographical reality cannot be synthesized in more than 3 elementary geometries: points, lines and surfaces. Each type of spatial pattern (also called sometimes spatial structures, even if arguable concerning the epithet) involves specific methodological approaches. As an example, the point patterns can be analyzed using the weighted centroid technique, the networks by using the graph theory and the surfaces by taking into account the shape of the polygons. Reducing the LAU2 or the LAU2 information to elementary geometrical features allows us to produce some geographic indicators that can be integrated in a local database. The interest of the spatial patterns analysis is not to fill fields of information in a table (it is also a method to increase the inflation of the information), it rather touches the need to intersect or relate indicators in an explanatory process (e.g. the local economic performance as an eventual output of the accessibility).

2.2 Using the spatial patterns as a base for the indicators construction.

Some of the techniques that we can use in order to approach these different spatial patterns will provide only synthetic indicators (the weighted centroid of the population or the standard distance deviation as a function of some central features, such as capitals). Producing specific information for each LAU2 situated in our 5 countries involves a different approach. Using the reticular spatial structures and the LAU2 centroids for Hungary and Romania we have explored the possibility to relate the geographical position of the spatial units to their position in a network. One of the common methods is to calculate distances in both the network and the geographical coordinate system. As a matter of fact, we have tried to confront Euclidean distances between LAU2 to the "real" distances in a network (the road network is sufficiently detailed to allow it). The obtained indicator is not quite an accessibility indicator, it rather functions as a network efficiency measure.

2.3 A case study on Romania and Hungary – the calculation of the LAU2 accessibility.

The Euclidean distances in a point spatial pattern reflect relations that might occur in an isotropic and homogeneous territory. The distances within the network will measure the relations that might occur in a historically planned transportation system. A comparison between the two kinds of distances allows us to map for Hungary and Romania a derived indicator of local accessibility. In both the countries the low values appears in the plain regions or in regions with a fair road network density. When the connectivity in the network is problematic or when we take into account the mountain zones, we observe higher values of the indicator. Sometimes, these high values are linked with the absence of some essential infrastructural features: a bridge across the Danube or other main rivers, sinuous transportation corridors. The deviation to the shortest Euclidean path will have an influence on the time distances and the cost distances, being sometimes an issue in the construction of the local economic performance. It also reflects the high degree of dependence on the mentioned essential infrastructural features and the lack of alternative road segments in the transportation process. In the Romanian case the high and problematic values of the indicator are specific to some remote LAU2 from the Carpathian Mountains and in regions with an intense relief fragmentation. In Hungary we observe a concentration of the high values in the southern part, confirming the spatial discontinuity effect of the Danube. Some LAU2 where not included in the calculation process because their centroid is not in the proximity of the road network (more than 10 km.). It is the case for LAU 2 situated in the Danube Delta (where there is no road network and the access is granted by water) and in very isolated mountain regions. One critical aspect of the two maps is the lack of harmony in the classification of values in the legend. The reason for this discrepancy is the conservation of the classification method – the natural breaks (Jenks). This lack of harmony also shows that low or medium values for Romania do not have the same sens in Hungary, where they can be considered intense deviations to the shortest Euclidean path. We can also speculate and think that in countries with a larger surface, the probability to encounter high deviation of the values is also stronger. There are some steps that we have to take into consideration when working with the road network efficiency indicator:

- verifying the topology of the network (the connectivity algorithm and the presence of bridges) is a long process. In its absence bizarre situations and extraordinary values may appear.
- Choosing an appropriate system of map projection is also needed in order to avoid exaggerated deviations for the Euclidean distances.
- The conversion of the Euclidean distances in km or other distance units should be carefully supervised.

Accessibility at local scale

Some of the ESPON projects already focused on the issues induced by the accessibility, but most of them touched only the NUTS3 frame. When the local dimension was taken into consideration, it was the accessibility to the various networks (roads or rails) that presented interest. One challenging intention would be to confront basic indicators of accessibility (the average distance that separates a LAU2 from all the other) in a double territorial context – the point spatial patterns and the network spatial patterns. The output of this approach reflects the relationship between the so called "natural accessibility" (the role of the natural features in the construction of the local accessibility) and the general characteristics of the road transportation network. The steps needed to complete this kind of analysis start with the construction of the Euclidean accessibility matrix. After that, the extraction of the average distance for every LAU2 is needed. A second problem is to build an origin-destination matrix in a common GIS. By summarization we will obtain the average distances within the network. The indicators will be put into a simple report and the road network efficiency measure is available for the mapping process. This efficiency refers only to the geometric characteristics of the network and it does not take into account the qualitative aspects. If we map only one indicator, such as the average distance that will separate each LAU2 from all the other, a core-peripheries model will appear.

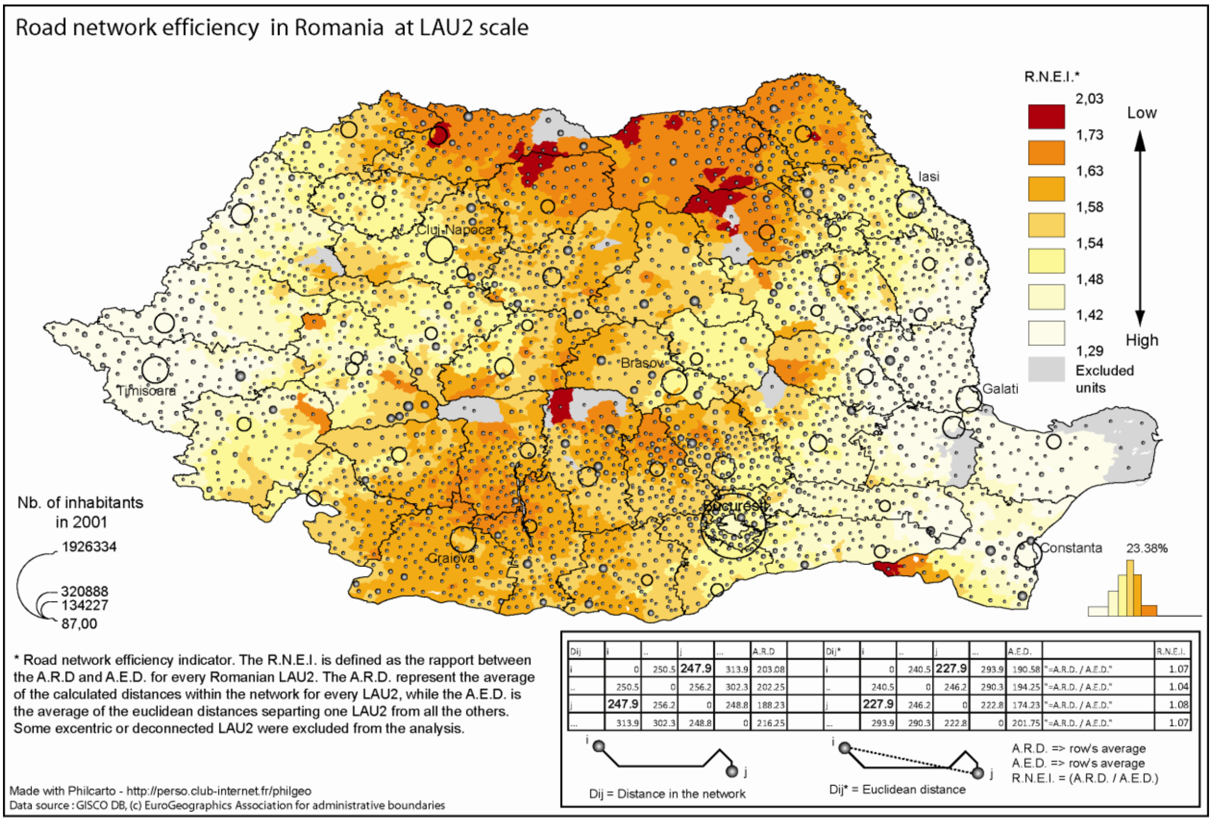

Figure 3 Comparing Euclidean distances and network distances in Romania

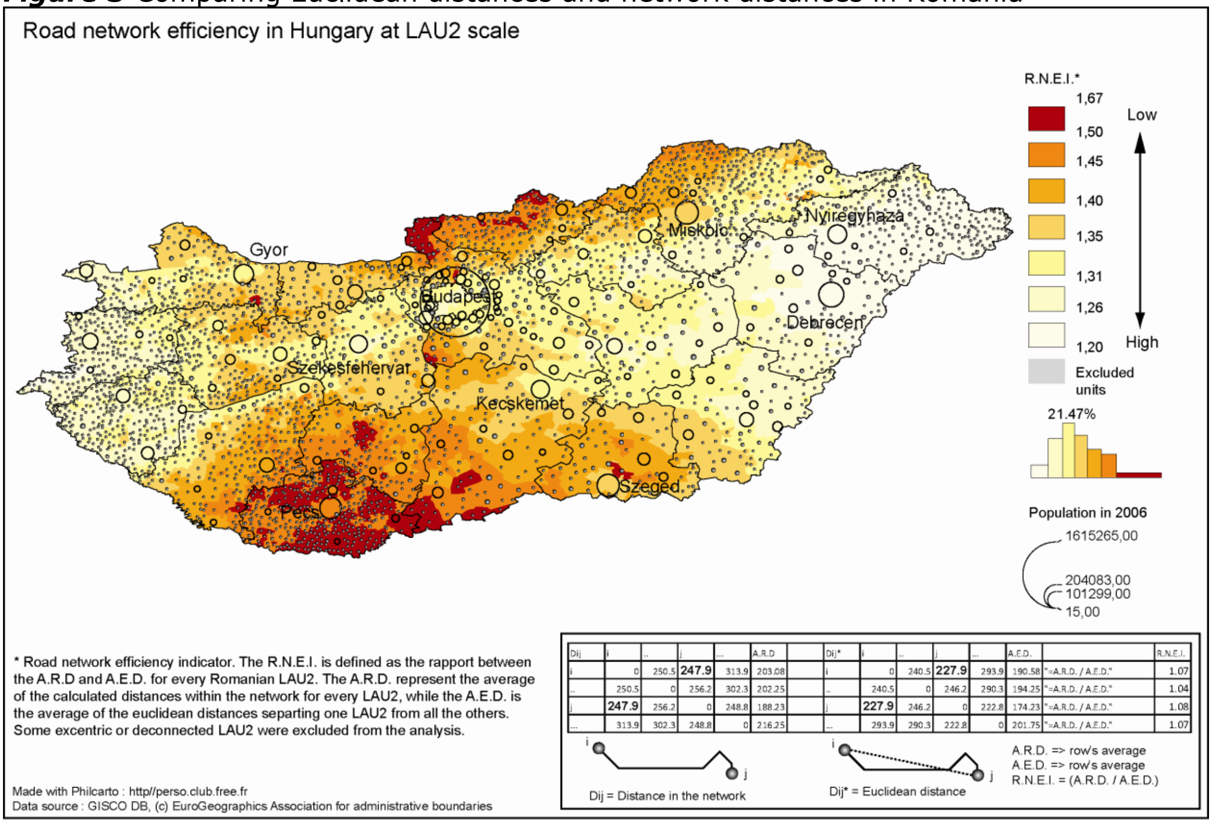

Figure 4 Comparing Euclidean distances and network distances in Hungary

In the absence of data, indicators like accessibility or deviation to the shortest path could become an interesting set of indicator, a tool in the exploration or description of territories at local scale. In their estimation process we mobilize the elementary spatial patterns (the points, the lines and the surfaces) and we use classical spatial analysis methods. The size of the studied region is an important aspect in the data creation. Despite the efforts, we were not able to work on a space with more than 3000 LAU2 (an approximate value) when calculating the Euclidean and the distances in the network. When we need to investigate the local accessibility for larger regions (two neighbor countries), solutions might appear if we change the working methodology and if we begin to split the table of information in data packages that don't exceed 10 million cells.

3 Towards more elaborate indicators and models applied to LAU2 objects. The potential of interaction as a measure for the local economic performance

3.1 How to measure the economic performance at LAU2 scale?

The economic performance is an important dimension in the panel of official indicators defined in the Lisbon strategy. Generally it is measured using the GDP (per capita, per employed or the rhythm of its formation) as a relevant picture of the economic success. However, this success is depending on the scale that we intend to use when we map it. At NUTS level (0,2,3) the spatial pattern in the repartition of the GDP is a core-periphery/peripheries matter of distribution. At local level (LAU), we can assume that this concentration is still visible, if we would have access to data. Possibly, this local concentration would have as actors the capitals, the metropolitan areas and some privileged rural regions. At the opposite, the low or under-average performance might be associated to some **remote areas**, still in transition regions or un-adapted urban networks. This eventual "jeu d'echelle" of the investigation would finally show how the repartition of economic welfare or performance is a subject to the spatial frame in which we try to fit it. For an external neutral reader, these assumptions might sound as the foundations of a hypothesis. Data concerning the GDP at LAU2 level is generally absent for the 31 countries included in the ESPON space. In their relative absence, it is impossible to confirm the existence of the **trans-scalar** spatial processes in the distribution of the economic performance. There are two options in this case: either the use of an alternative measure for the economic performance, either to try to estimate the values for every single LAU2. We have explored the two possibilities, taking into account that the recommended solution should be a dominant strategy for an eventual research group working on the local databases. The first solution is to explore unofficial but reliable data sources that can offer indicators on the economic trends at local scale, knowing that harmonization with other countries will be a difficult task to assume. The second option is to approximate/estimate the values using **spatial analysis** techniques.

Remote areas

These territorial units could be considered only one dimension of a larger concept: the territories with specific geographical features (ESPON, 2006).

However, the specificities are not equivalent to some territorial lack of assets, especially when zooming at local scale.

Trans-scalar

A geographical attribute of the spatial distributions that intersect the MAUP (modifiable area unit problem). Basically, one territorial repartition might not have the same pattern, when we observe it at different scales of analysis.

Spatial analysis

According to the modern classifications, the spatial analysis is a method used to observe and measure the spatial structures. In the GIS, especially in the mainstream of the specific jargon, the spatial analysis is a technique used to perform topologic and logic operations between the spatial features: join operations, intersections, updates of geometries etc.

3.2 How to find relevant and harmonized data for this operation? A case study on the local aggregated turnover in 2006 – the Romanian case.

In Romania, but also in other countries from the ESPON space, accessing data concerning the economic performance at local scale is a challenge. During our networking activities with the official data providers, we have found two significant facts about this type of indicator: 1) the Romanian NSI doesn't necessarily gather it; 2) other official databases, such as the Ministry of Industry, will provide data aggregated by branch at NUTS scale. If GDP is not free and officially available at LAU2, we can use other reliable data providers in order to obtain information about the economic success at local scale. One way to do it is to integrate data about the economic actors that are present in a certain territory. In the Romanian case, we have downloaded and exploited a free product (a database with more than **600 000 firms** and the basic information about their economic behavior: nb. of employees in 2006, the turnover in 2006 and the foreign direct participation). In other ESPON countries, similar products might be available. This free package of data present reliability for several reasons: the data is available for consultation and validation passing by other sources (the Ministry of Finances); the territorial picture fits the expectations and the recent trends. The values concerning the firm's turnover were integrated by matching the name of the settlements with the **SIRUTA codes** (Romanian NSI official code) for more than 12 000 spatial units that compose the 3000 LAU2 from this country. It was a challenging case study because it involved a large amount of data, specific matching algorithms and it also offered a general picture of what is happening under the LAU2 level. Practically we summarized the turnover of all the economic actors that are active in a Romanian LAU2. This approach has advantages and weakness that we will discuss next.

Firms

As economic actor, the firm might have different definitions from one state to another. Their number of firms is also a subject to debate, if one will take into account the variety of purposes for which firms appears in an economic system. In the Romanian case, some of the data is an average of the values for the reported year (e.g. the number of employees in 2006). For multinational firms with antennas in the local territory, the data is furnished for the LAU2 of the headquarters and not for the production of sales compartments (e.g. if the social siege is in Bucharest and the production in Iasi, the data is attached to Bucarest).

SIRUTA code

A unique identification code proposed for all the settlements in Romania. The equivalent LAU2 code is called SIRSUP (superior SIRUTA). It is sometimes a problem for the matching operations because it is different from the codes in the basemap database.

Advantages: a clear picture of the economic performance at local scale, especially when data is smoothed (different methods are possible). In this case, an archipelago-like territorial structure is shaped by a West-East gradient. The data can be used in order to multiply indicators: turnover per employee, local discontinuities or trans-scalar analysis.

Disadvantages: The data is expressed in national currency (1 RON is the approximate equivalent of 0.25 Euro) and a conversion should be made. A good knowledge of the territory should be mobilized in the map interpretation. Some of the values might look as an outlier in the territorial context – the case of Medias and Mioveni, two cities that take profit from the headquarters effect (EON GAS and Renault, two major multinational firms are located in the mentioned LAU2). The same effect could be the cause of an over-representation of Bucarest. The contextualization at an upper scale (Bulgaria and Hungary) is impossible for the moment and an eventual approach should overcome large problems of harmonization (e.g. in the case of Bulgaria, data might be available at LAU1 units).

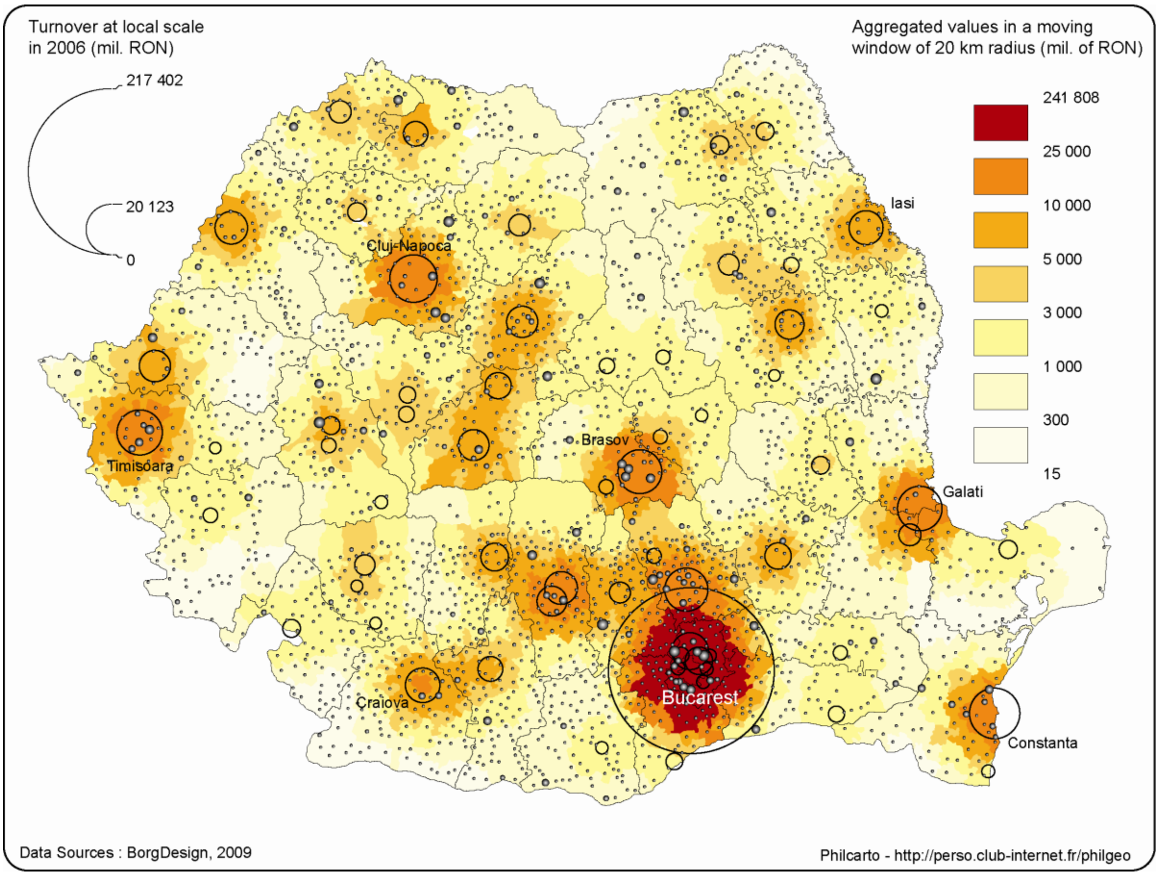

Figure 5 The distribution of the aggregated turnover in 2006 – Romania

In 2006, the distribution of the economic performance at LAU2 scale is an aspect of the strong metropolitan concentration. Some of the regions are better situated in this equation: the west of the country or the urban network of Transylvania. Moldavia (East) and some rural peripheral regions in the South are less visible on the map. There are several reasons for this situation: gradients of economic growth, high costs of transportation or a lack of urban economic engines. This situation is also reflected in the distribution of the welfare.

3.3 How to by-pass the lack of harmonization using grid information?

In ESPON DB 2013 Challenge 5 a specific methodology was developed in order to disaggregate data expressed at NUTS level in a grid (1km). The basic indicators are GDP, unemployment and active population for 2003 and 2006.

At the base of the estimation, the methodology used the distribution of population in a 1km grid and the CLC 2006 classification on the built-up area. This deliverable can be used in the analysis of the economic performance at local scale in two ways: mapping the GDP 2006 in the grid or aggregating the data in the LAU2 frame. In the second case, we will obtain an estimation of the distribution of GDP at the scale of the municipalities.

3.4 Integrating disaggregated data (GDP at NUTS 3 level expressed in a grid of 1km) on the LAU2 geometry frame – a problem of spatial matching.

Despite the number of elements in the grid that have to be manipulated, the technical and methodological operations are not as complicated as one might expect. There are at least two ways to deal with this problem. The first one is to intersect every cell of the grid with the LAU2 geometry. In that case, we will obtain a large number of new polygons that contain information (GDP). Weighting the surface of the new polygons with the values for the requested indicator will approximate the share of GDP in every polygon. However, this method is time and computer resources consuming and it involves the manipulation of many spatial objects. It also has the advantage of the best precision in the estimation (to debate). A second option consists in the by-passing of the surface weight estimation and the use of the centers of every grid cell. As a matter of fact, the 1km grid cell is just a geometrical container of the information that can be reduced to one point. Intersecting the values of the point (GDP) with the LAU2 spatial frame will allow us to estimate (by summarization) the GDP at local scale. From a certain point of view, both methods are useful, it just depends on the context in which we apply them. The first one is suitable for regional research, the second for a large amount of LAU2.

Data aggregation from the 1 km grid. 2nd method

1. Don’t expect to finish very soon the aggregation for all the ESPON space. First, choose your region.
2. Create by dissolving the LAU2 limits a mask for the studied territory.
3. Extract by this mask the grid cells that present interest.
4. Create by extraction or selection the LAU2 map of the area. Make sure to have the same time reference as the indicator (e.g. 2006 layer map for GDP 2006 indicator)
5. Create centers of the grid cells. You should obtain a dot/point map. Be sure to join the information to this new spatial frame (GDP or other indicators).
6. Intersect these centers with the LAU2 map of the area. A large file containing both the codes and values of the grid and the codes and values of the LAU2 shall be created.
7. Summarize data using the LAU2 code. A new table shall be created. This table should be saved. Else, go to Step no.1.
8. Join this table to the LAU2 spatial frame and map the result.

Choosing one method or another, the specific issues of spatial matching cannot be easily overcome. One major problem is to balance the degree of

generalization of the grid data representation with the geometry of the LAU2. The spatial frame for 2006 is not always perfectly overlapping the **CLC 2006** grid in which the information (GDP values) is contained. This problem is especially occurring **in the border or coastal zones**, making the estimation difficult. It is also a problem for areas with a high fragmentation of the administrative frame (the municipalities are represented as tiny polygons, intersecting 3 or 4 grid cells). The Czech Republic and Bulgaria are good examples for this last issue. Another spatial matching issue is occurring when we have to take into account the features of the natural environment. Many large LAU2 have lakes on their territory or areas with high elevation. The grid estimation method doesn't exclude them, even when their surface is limited. However, we can assume that even these areas present a contribution to the GDP creation by some economic activities taking place in relation with these zones. Sometimes the grid model penalized them (in regions with touristic vocation), sometimes not (when the natural areas present a considerable human pressure).
A zooming illustration (fig.7) of these spatial matching methodological problems is presented in the cross-border region of Dobrogea, situated on the shore of the Black Sea (Romania and Bulgaria). The map indicates that the distribution of the GDP in the grid could also be the subject of a strong territorial auto-correlation effect, induced by the NUTS0 or NUTS3 regions. On other cross-border area (Romania and Hungary or Czech Republic and Slovakia) this effect is less present in the mapping result.

Methodological solutions

In the **border or coastal zones** the data integration from grid to LAU2 is more difficult. For the border we can apply a solution based on the weighted surface of the cell intersected by the frontiers. As long as the shape of the frontier is the result of a dissolve option in a GIS, we have a good degree of shape precision. The calculated values can then be included in the file.
For coastal areas a solution based on buffers may be imagined. For every LAU2 that has a limit on the sea we can create a buffer of n km and calculate the values of the indicator. We are now looking for a solution able to optimize and accelerate these two methodological options.

Land use data integration

Using the spatial analysis GIS methods, efforts were made in order to integrate CLC 2003 and 2006 data in the LAU2 geometries. This operation involved the intersection between the CLC 2003 classes and the LAU2 frame. The eventual output of this method would be a LAU2 typology based on the internal land use. Sensible to map projection and map scale, the measurement provides some errors. Taking into account the differences between the CLC 2003 classes and the national land use typologies, these errors are difficult to correct. Due to the large amount of time involved in this operation, the CLC data integration is available for only 5 countries.

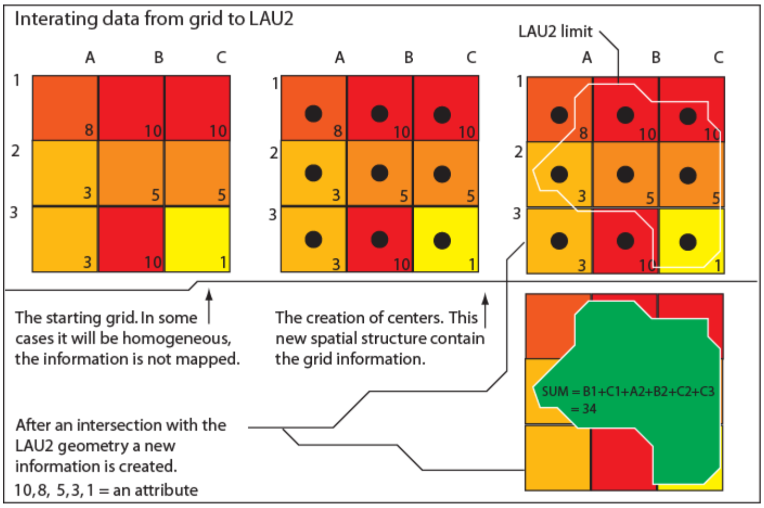

Figure 6 Graphic representation of grid data integration in the Lau2 geometry

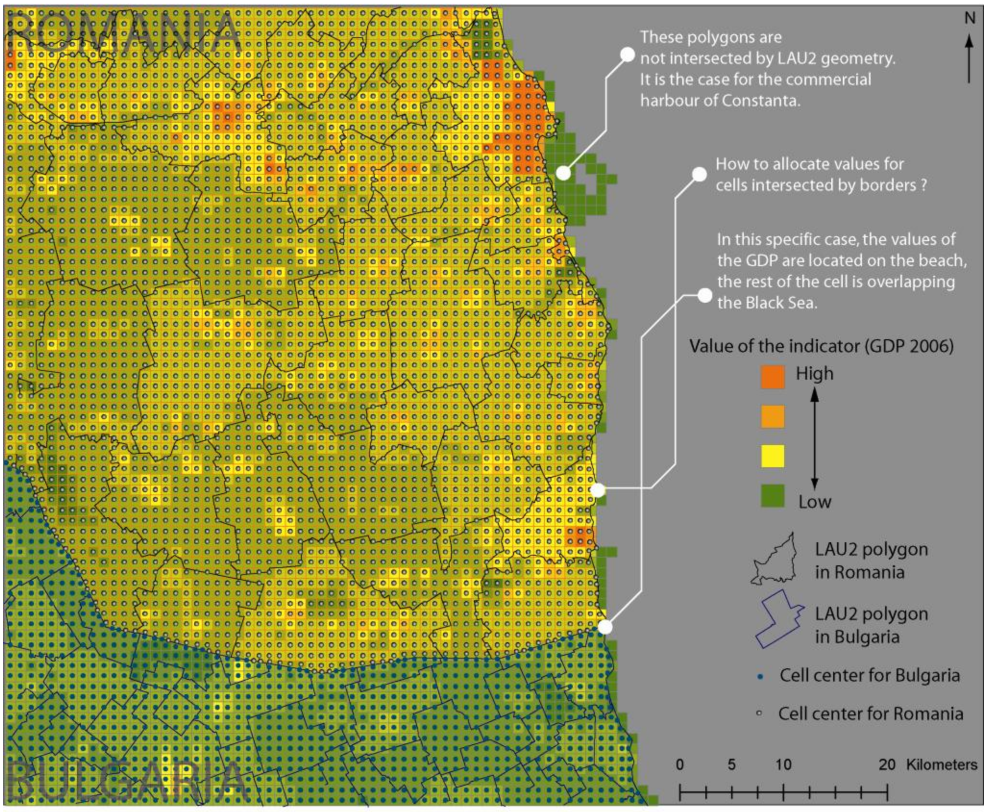

Figure 7 An illustration of the methodological issues induced by the grid data aggregation at LAU 2 scale

The main question behind this map is how far we can go with the estimation of values at local scale. The harbor of Constanta is serving the city itself, the NUTS 3 of Constanta, Bucarest and Romania. As a matter of fact, it is not an object that should be excluded from a larger spatial context. Its infrastructure is overlapping a nearby LAU2 (Agigea), a municipality almost completely integrated in the metropolitan area of Constanta. As in any port, a constellation of firms are located and they do contribute to the GDP creation. Some of them locate in Constanta, some of them in the LAU2 of Agigea. In the last case, firms are locating in order to take profit from the fiscal advantages of the free-tax zone active in the port. The both categories of economic actors use the port's infrastructure and depend on the metropolitan links created in the recent period. Allocate the GDP from cells to one LAU or another is an attempt to perfectly map the trees and not the forest. As a compromise conclusion, the GDP is created in the area of Constanta and not in the municipalities. This area can be defined as a potential LAU1 region (neither LAU2, neither NUTS3, neither FUA, but relevant for a better integration of the local data) or it can be estimated by quantitative modeling. In Romania and some other ESPON states the LAU1 administrative level of data collection is absent. The only remaining option is to "smooth" the data by a potential of interaction model.

The integration of the grid data in the LAU2 frame was performed for 5 selected countries: Czech Republic, Slovakia, Hungary, Romania and Bulgaria. The operation involved more than 20 000 LAU2 and this considerable amount of spatial units is caused by the high degree of administrative fragmentation in 4 of the 5 states (if we also take into account the western part of Hungary). As we have integrated the 2006 values of the indicators in the 2006 LAU2 geometry, some corrections were necessary because all the capitals (except for Sofia and Prague) and some major Slovakian cities (Kosice) are divided in spatial units with LAU2 administrative competences. In the case of Bucarest, we have 6 sectors. Consequently, the data was summarized according to the most central division of the capitals, usually the sector no.1 or the Staro Mesto (the old center). A second step in the data exploration was to map the result in order to verify if extraordinary values or errors are interfering with the methodology that we used. This step works like an "expert opinion" validation of the collected or integrated data, but it is based on the visual survey and it has obvious limits. The mapping options are basically limited – symbols or choropleth design. In both cases the mass effect will be present on the map and by mass effect we understand the high distance that separates the capitals and the large cities from the rest of the urban or rural entities included in the settlement's hierarchy. A better visualization will occur if the data is smoothed (GDP in 2006 at local scale, unemployment or active population) and this better visualization is needed if one will think that we are working with the local data and not with the cities. Smoothing the data also involves a choice to be made between the methods: the average values within a rank 1 neighborhood, the summarized values in a cut-off distance neighborhood or a model based on the potential of interaction of all the LAU2 units. Some of the options take space into account in a discrete way, the last one (the model of spatial potential) in a continuous manner.

Building the model

After the inclusion of the grid data in the LAU2 frame, we have prepared a model of potential of interaction that usually works when the values of the parameters are well approximated. The three variables that we had to take into account are: the interaction function, the distance decay function and the mass (the GDP in 2006 estimated for all the LAU2 in the 5 selected countries). In a classical model the interaction function and the distance decay are based on some constant values. In our model the two variables are receiving multiple values, being weighted with the demographic rank and with de road network density in the area.

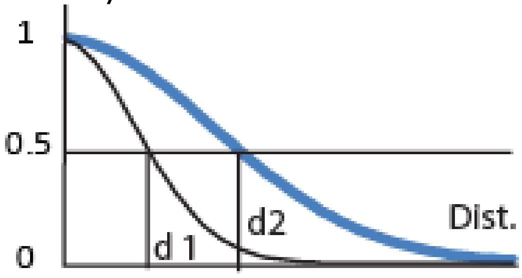

Figure 8 **A graphical formalization of the model**

d1. Radius of a certain distance for a LAU2

d.2 Radius of a certain distance for a LAU2 with a larger mass.

The black and the blue lines simulate the decrease of the interaction as a distance function.

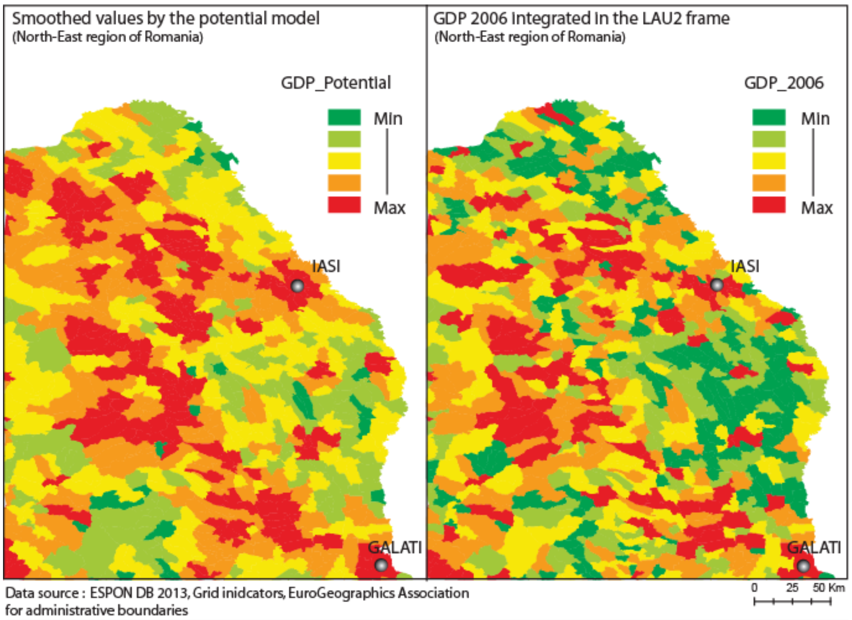

Figure 9 Smoothed values for GDP_2006 at LAU2 scale vs. the estimated values of GDP_2006

3.5 The calculation of the potential model of interaction for the local estimated GDP

In a classical model of potential interaction, we assume that at a “certain distance” from a spatial unit the interaction decreases at 50 % (if we use a Gaussian negative function). We also take into account the friction of the space by using a distance decay function with 2 as exponent (the canonical 2). When we apply the model we can calculate for every single spatial unit how much “interaction” will receive, if our assumptions approximate well the reality. We can better translate this into English by using an example. Let’s assume that we want to calculate the potential interactions for Prague. First, we will assume that all the interactions are reduced to half at 20 km. This means that 50 % of the flows are collected in a circle with 20 km radius. The other half, obviously beyond 20 km. We will also take into account the friction induce by space (we will use 2 as value, not too much friction according to the classical models). If one will try to validate this model for Prague using the commuters flows as an empirical validation, he will observe that we were wrong in our assumptions. Prague collects 50 % of its flows from a 45 km radius, while the distance friction is only 1.2. Unfortunately, for the GDP 2006 potential of interaction we cannot validate our assumptions because we don’t have the local economical flows, but our model is also supposed to work as a smoothing method for the data. If we reproduce the calculations for Brno, we will observe that the radius is about 25 km and the distance decay has 1.8 as value. One important aspect induced by the empirical “validation” is that we cannot use constant values as parameters.

Our model was built using a variable radius for the interaction function and a variable distance decay parameter. The variability was mathematically induced by using the demographic rank as a weight for the radius. The capitals received 20 km radius (in a Gaussian function) while the other cities values vary between 15 and 1 km, according to their rank. The distance decay was calculated using the road network density (high density = low friction (1.7), low density = high friction (2.3)). The road network density was estimated by intersecting the reticular spatial structure of roads with the LAU2 geometry. After this preliminary “mise en scene” of the parameters, the model was applied for more than 15 000 LAU2. Bulgaria was excluded in the absence of a network reliable file.

With this approach the smoothed values present more interest than the basic GDP disaggregated at LAU2 scale. Our intention was to eliminate the noise from the map and leave intact a territorial structure that also allows seeing the local (Figure no). We preferred to use a spreadsheet for the calculation rather than a GIS model, because the methodology can easily be reproduced by interested users. Limited by the hardware, we were forced to implement the model in packages of 15 000 LAU2 x 500 LAU2 (until we finished them all), but other strategies are possible too. A second intervention in the data was necessary, this time in order to allow the mapping process – the values were standardized using the limit of the second hierarchical class (100), letting all the superior values floating to the maximum (Budapest). There are two ways to interpret the cartographic result. A first strategy will try to seek for the outliers and the extraordinary values and the second one involves the mobilization of the spatial structure concept.

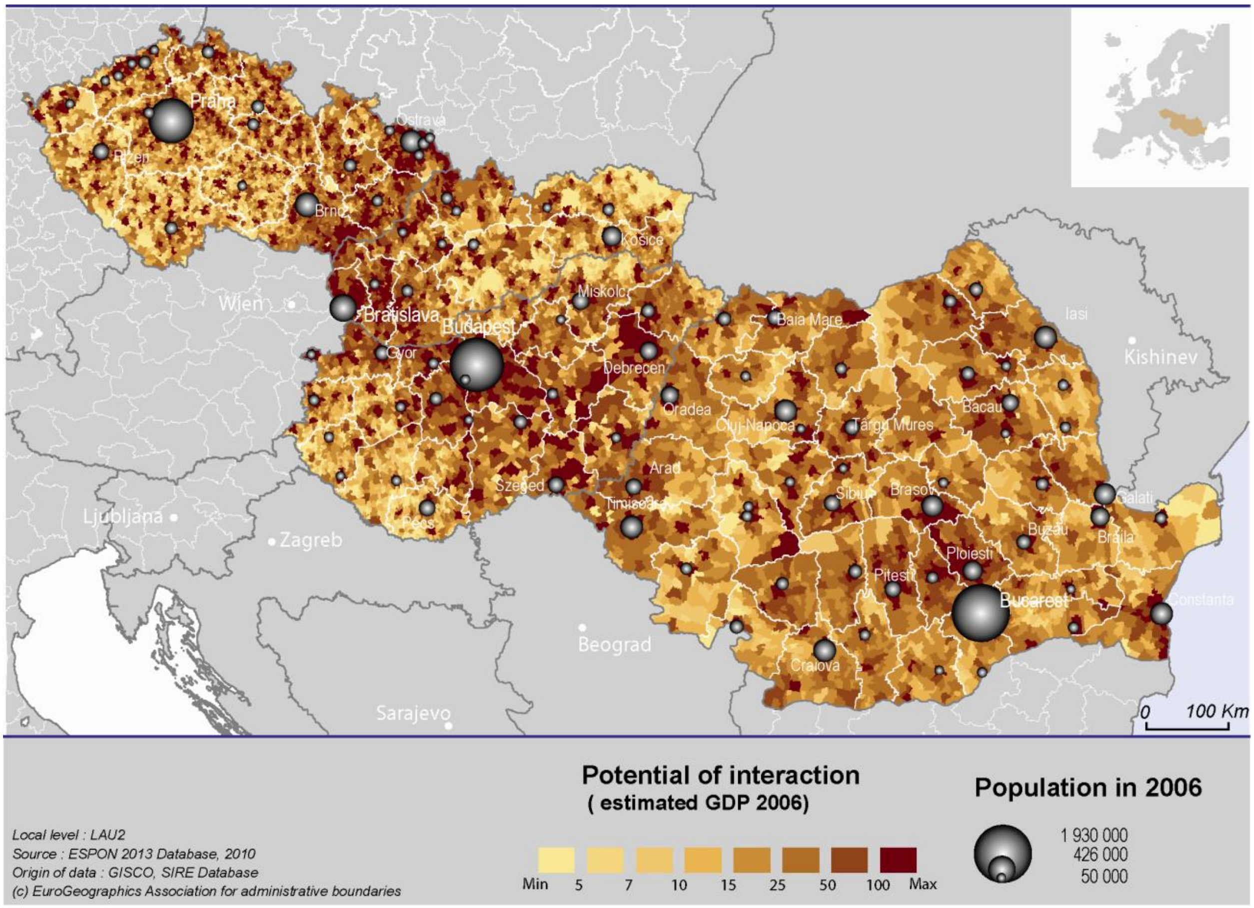

Figure 10 The potential of interaction for the GDP estimated at local scale in 2006

Key findings from the map

The economic performance is a matter of scale and mass (demography and surface).

After modeling the distribution of the GDP 2006 at local scale we can observe that the spatial pattern of this repartition is influenced by the size of the LAU2. In Hungary and Romania this phenomena is clearly visible. At the opposite, areas with high administrative fragmentation (in Slovakia or in Czech Republic) seem to be penalized even after the data smoothing. This regularity is less present in the East of the Czech Republic and in the northern region of Bucharest, two zones specialized in industrial activities.

Long run trends are still present – the key role of the modern industrial regions

After the transition period, the industrial regions (some of them old, some of them emerged or modernized during the socialist period) seem to regain a comfortable position in the GDP hierarchy. At local scale, these industrial basins are extremely important if one will take into consideration their impact on employment or in the welfare creation. These regions (e.g. Ostrava in Czech Republic, Gyor in Hungary, Pitesti-Ploiesti in Romania) are there to complete the metropolitan economic nodes and their conjuncture fragility is balanced by resilience, adaptation and integration in the European economy.

Spatial discontinuities and interfaces: when frontiers are uniting trends of economic performance.

Transforming the frontiers in interfaces that filter the flows of persons, goods and information is a constant trend in the Eastern European countries. In some cases, these frontiers may also work as attractors for the economic activities, such is the case between Romania and Hungary or partially between Slovakia and Hungary. The real discontinuities in the local estimated GDP 2006 distribution seem to be internal, sometimes overlapping old historical limits (Moldavia and Transylvania for Romania). Maybe the new economic paradigm that installed in the transition and pre-adhesion period reactivated these old frontiers, shaping new logics of economic performance compared to the past.

Some of the remote areas are quite well. The regions in difficulty are still precise.

Without being a rule, some of the remote regions and areas with specific geographical features are not marginalized in the distribution of the economic performance (the coastal regions are quite dynamic, some of the mountain areas in the Carpathians present decent values of GDP due to recent turistification and re-industrialization and some of the border regions behave as economic attractors). The regions in difficulty locate (without being a clear regularity) in the "no man's land" of the metropolitan and urban polarization, making us to assume that the economic performance could be a distance decay function towards the nearest city.

4 Towards more elaborate indicators and models applied to LAU2 objects. The settlement hierarchy and the territorial architecture of the selected countries.

4.1 Using the distance as an indicator for territorial coherence in the Eastern Europe

Distance is still an important component that shapes the local space in the selected countries (it filters the flows, it may explain how the economic performance is distributed or how the urban network is functioning). Working with the distances at LAU2 scale is complicated if we take into account the large number of spatial units. However, not all the distances are relevant or interesting in an eventual study. If we want to compare how the estimated GDP at local scale in 2006 is distributed in relation with distance to the nearest city, we will work with a reasonable quantity of elements in the matrix (about 15000 LAU2 x almost 100 spatial units). In this case we can proceed to the calculation of distances using the regional road network. If no GIS instrument is available, the Euclidean distances can also be estimated using the classical model. Both methodologies involve a number of compulsory steps to check, in order to obtain the "oursin" map that we seek for.

4.2 The settlement's hierarchy – how many levels function from Prague to Sulina?

As our intention is to put in relation LAU2 s and cities in the selected countries (Czech Republic, Slovakia, Hungary and Romania) and as the definitions of the cities are heterogeneous, we have assumed that the starting point should be the choice of a demographic cut-off in the urban hierarchy. The analysis of the rank-size distribution for 2006 population shows that 3 hierarchical levels are clearly visible in the region: the capitals, the so called "large cities" (over 128 000 inhab.) and the medium sized cities (over 50 000 inhab.). As an alternative, we could use the distinction between FUA and MEGA, qualitatively complicating the model. These three demographic levels were put into relation with the LAU2 using the distance in the road network as an indicator for some potential and theoretical urban influence area. If there is any association between the economic performance and the distance decay based on cities, the mapping process and the interpretation should show it. We also could assume that this relation will work better in a homogeneous space, like Hungary. That's the reason for focusing our cartographic processing and argumentation on this country. Of course, if we could make the map readable.

Steps to obtain a link map

1. Every map comes from software. From the point of view of the software, not every sum of lines is a network. Manipulation is needed in order to obtain nodes and links in the network.
2. In the case of an oursin map, not all the points (LAU2, cities, features) shall be involved. The eventual user should think that what he will obtain will be an origin vs. destination asymmetrical matrix.

3. The origin vs. destination matrix will be provided in a vector format which is sometimes difficult to manage.
4. In order to obtain the minimal distance that separates a LAU2 unit from the cities (our case) an interrogation in the matrix is necessary.
5. After the interrogation is applied, a new vector matrix is obtained and it will be saved. Else, go to step no.1.
6. The data obtained from the calculation offers two mapping options: links or choropleth. The links can be used to emphasize the shape of a theoretical zone of urban influence, the choropleth its limits.

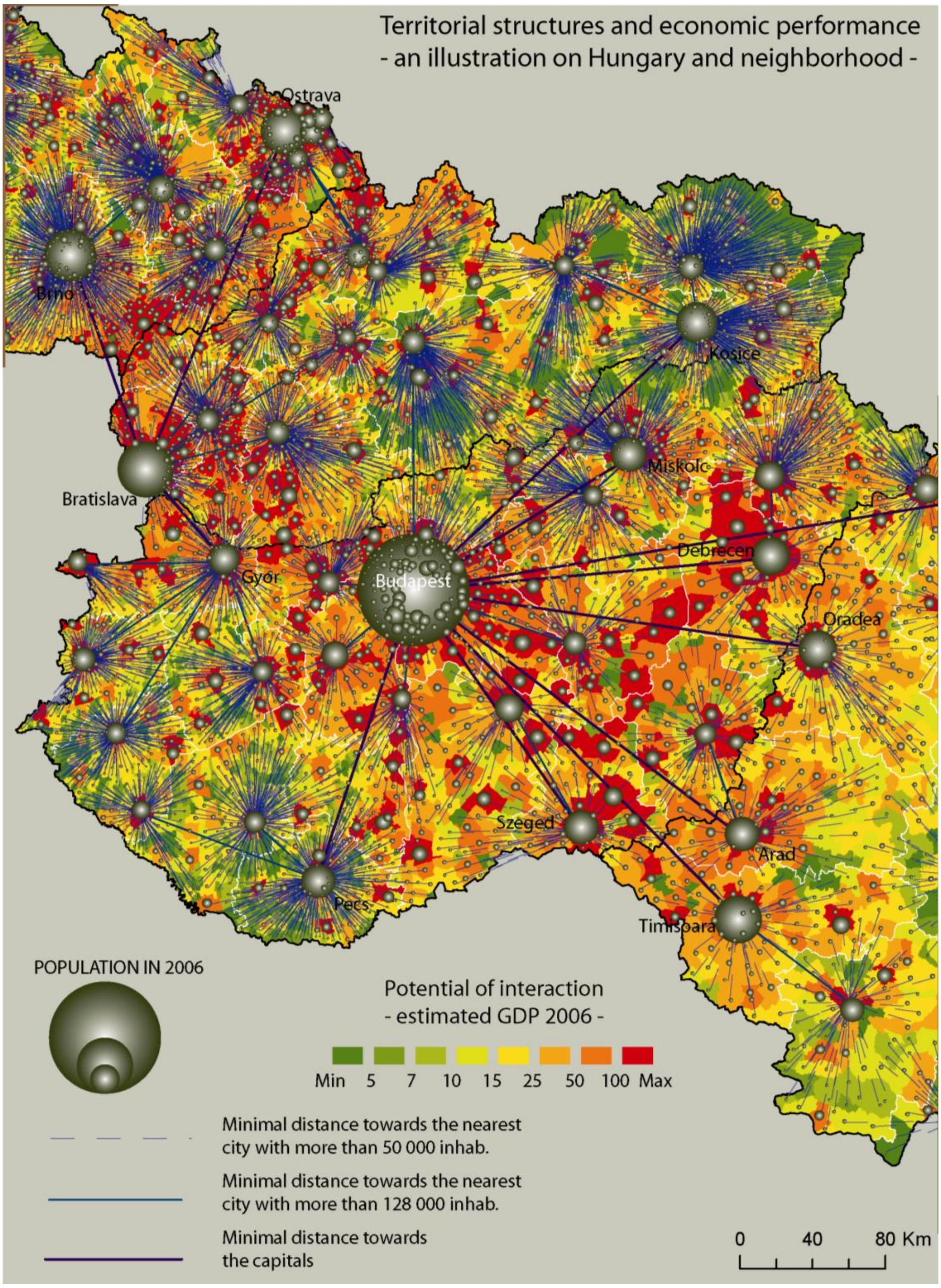

Figure 11 Distances and economic performance in Hungary and neighborhood

4.3 How to map the distance: choropleth vs. "oursins".

If one will use the minimal distances as an indicator for the territorial or administrative fragmentation at the local scale, the mapping method will be an issue to take into consideration. Using the LAU2 polygons for the cartographic product will produce a "tropical fish" like map. At the opposite, the link map will provide an agglomerated picture of the territorial structures, emphasizing the shapes rather than the limits of the theoretical zones of influence. The main advantage of the second map type (links or "oursin") resides in the opportunities that offer to hierarchically imbricate different distance levels. (e.g. LAU2 vs. nearest city with more than 50 000 inhab., nearest city with more than 50 000 inhab. with the nearest city with more than 128 000 inhab., the nearest city with more than 128 000 inhab. with the capitals). In a choropleth map only one kind of distance could be mapped, excepting the case where we use a cluster analysis. If the LAU2 used as destinations are too dense, there is a risk to make the map unreadable (which is the case for Slovakia or Czech Republic, in our illustration).

4.4 The local fragmentation of the territorial architecture and the hierarchical immobility.

The relation between the economic performance and the distance towards the nearest medium (50 000 inhab.) or large city (128 000 inhab.) seems to obey to a U shaped like function rather than a classical power decay function (based on the observations made on Hungary and neighborhood). This output has two explanations: the christallerian pattern in the city distribution or errors induced by the aggregation method (GDP for 2006 in a grid format to GDP 2006 in LAU2 frame, smoothed by a potential method).
In many local cases, the shape of the theoretical urban influence area is largely overlapping the NUTS 3 limits. It is not the NUTS3 limit that should be put into question, but the limited number of destinations used by the model.
The national borders are irrelevant in the design of the capital's theoretical areas of influence. Some western cities in Romania are closer to Budapest, than Bucharest. Their local hinterland too, inducing some sensible questions regarding the equilibrium between national and trans-national public planning policies.
The context does matter and by context we can imagine the role that would play MEGA such as Vienna in the context of the Eastern and Central Europe. How the potential interaction of the GDP 2006 (locally estimated) would be reshaped, if Vienna were on the map?
In the eventuality of a recalibration of the hierarchical demographic levels (using 27 000 inhab. instead of 50 000), the relation between economic performance and distance towards the nearest city will take (maybe) another form. However, at the top of the hierarchy, the situation will present few changes and Oradea will still be closer to Budapest than to Bucharest. The hierarchical immobility will still function, it is the local that will present interesting dynamics.

The corridors of welfare are complicating the gradients and the core(s)-peripheral spatial patterns present on the map. Some of these corridors reply the major transportation network, some others the linear proximity to economic engines or consecrated MEGA. The disconnections in relation with the metropolitan nodes sometimes give them the attribute of fragility or territorial tunnel effect.

Conclusions

These conclusions are organized as a set of relevant key findings concerning the problematic of the LAU2 scale of analysis. As the main studied are is composed by 5 countries situated in a particular geographical context, these conclusions cannot be extrapolated to other states.

At the horizon of the year 2006, the demographic decline affects an area of the size of a medium ESPON country. The process presents spatial homogeneity and has chances to become a trans-scalar and cross-border issue, relevant for policy decision.

The demographic growth is possible, even in a context of turbulent economic performance. It almost concerns only the large metropolitan areas and some regions with specific geographical features.

The elementary spatial patterns (points, polygons, networks) can be mobilized in the production of relevant indicators for the local territories. Basic techniques of spatial analysis can be implemented, even when we deal with a large number of LAU2. It is the case for the accessibility at local scale.

The economic performance at local level is a matter of scale and mass (demography and surface). As an hypothesis, it also might be linked to some patterns of spatial organization (territorial auto-corellation or the effect of territorial belonging).

The modern industrial regions still play a role in the distribution of economic performance in the Eastern Europe, together with the large metropolitan areas.

The frontiers are not always behaving as spatial discontinuities. In some contexts, the border is uniting trends of economic performance. Such is the case for the frontier between Romania and Hungary.

Some of the remote areas are quite well, despite their lack of accessibility or their under-average territorial integration. The regions in difficulty are still to be precised, but using a combination of indicators derived for the local scale (economic performance, land use patterns, accessibility and theoretical connectivness to the metropolitan areas) will allow the development of a methodology.

Annexes

Land use data integration in LAU2 geometry

In some contexts, working with a large amount of data at local level is counter-productive for two reasons: data manipulation is becoming an extremely time-consuming process, even for simple operations and the level of map visibility might be compromised by the number of polygons. That's why an option was made to produce indicators only for a limited number of countries (Bulgaria, Czech Republic, Hungary and Slovakia), indicators that were previously spatially and chronologically harmonized. This space covers an interesting area from Central Europe to the Balkans, allowing us to test different methodologies (data collection, indicator creation and harmonization) for sufficiently large dataset (almost 25 000 LAU2). In many cases, the indicators provided by the NSI were available only for a country or two, not allowing us a complete collection of data in order to cover the mentioned space. In this case, looking for indicators that are covering the 5 countries might present much more interest and added value compared to five different indicators which will cover separately each of the 5 countries.

One exploratory dimension in our work was to integrate data about the land use at local level, both as absolute and relative values. Taking into account some of data collection problems that we have already mentioned, it looked naturally to explore the possibility to integrate data from the European Environment Agency (the CLC 2006 vector data) in the LAU2 geometry. The methodological steps are not extremely complicated but (again) time consuming:

1) Data download – 44 layers of information were extracted (http://www.eea.europa.eu/data-and-maps/data/clc-2006-vector-data-version).
2) Data extraction for the 5 countries chosen for the test (GIS operation: extract by a mask/clip formed by the concerned region).
3) Geometry re-projection in order to obtain surfaces for LAU2 and the land use layers.
4) Intersection of two layers (LAU2 geometry vs. land use layer – e.g. LAU2 2006 geometry intersected with the green urban areas). The operation was implemented 35 times for each land use layer.
5) For the new objects, the surface was calculated and summarized for every land use category, according to the LAU2 2006 frame.

The results of this operation were systemized in compliance with the CLC2006 classification, as follow:

1) Surfaces in square meters for every land use category of rank 3. Relative share of a land use category as percentage in the LAU2 surface. (e.g. C221 represents the vineyards surface in the LAU2 and the CREL221 the surface of vineyards as % in the LAU2 geometry).
2) Surfaces in square meters for every land use category of rank 2. Relative share of a land use category as percentage in the LAU2 surface.

(e.g. C22 represents the permanent crops surface in the LAU2 and the CREL22 the surface of the permanent crops as % in the LAU2 geometry).

3) Surfaces in square meters for every land use category of rank 1. Relative share of a land use category as percentage in the LAU2 surface. (e.g. C2 represents the agricultural areas in the LAU2 and the CREL2 the surface of the agricultural as % in the LAU2 geometry).

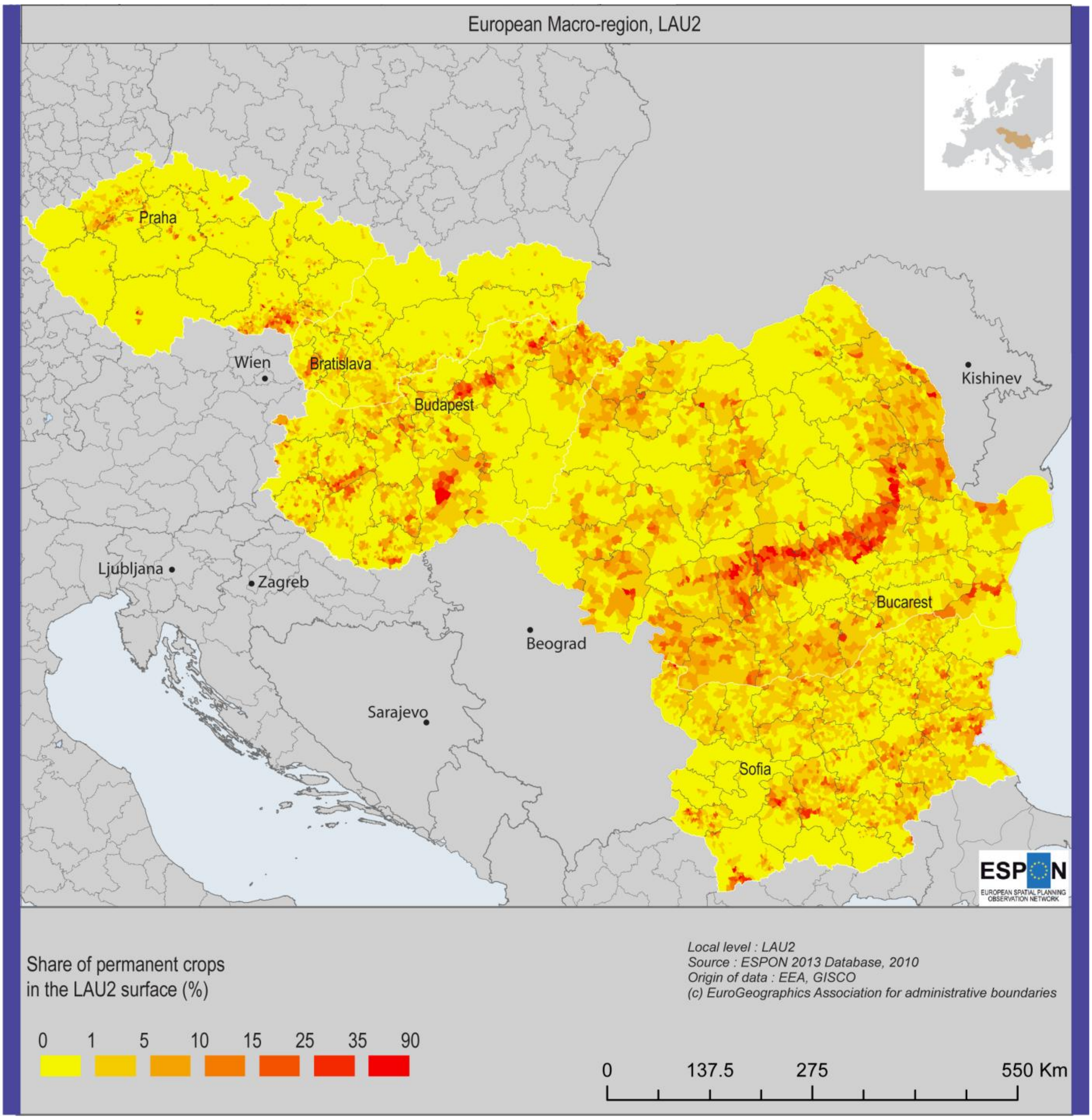

Figure 12 Share of the permanent crops as percentage in the LAU2 surface in 2006**.**

The table is populated with 70 indicators for the first type of land use (rank 3), 30 indicators for the second one and 10 for the rank 1. Some categories are not represented for obvious geographical reasons (olive crops, glaciers or intertidal flats). Concerning the utility and the data quality, there are some aspects to emphasize and discuss. Eventual errors in the data table might occur from the combination of several factors: the CLC methodology of classification, the degree of generalization for the LAU2 polygons and the projection of data in the system of coordinates. Consequently, the values of the land use categories at LAU2 2006 level should be considered as approximations of the reality.

Despite the data quality (which might be questionable), there is a double interest related to these indicators and to this methodology. From a theoretical point of view, having access to a general picture of the land use offers some opportunities to create new indicators (e.g. location coefficients for the artificial spaces), to provide or to refine spatial typologies or to better define territories with specific geographical features. If we take the example of the permanent crops (vineyards and fruit trees), the map will allow us to better understand how patterns of "stable" agriculture are organized in this European macro-region. Being quite and exigent form of agriculture because it demands specialized labor force and superior agronomic skills, the permanent crops may play a key role in the economic development for some privileged rural areas (Sub-Carpathians in Romania or Tokay region in Hungary). In the same time, a high degree of specialization might become problematic in contexts of economic instability or in confrontation with natural hazards. This kind of indicator, combined with other datasets available at local scale (accessibility, economic performance), can be used in order to better shape territories with specific economic vocation, taking thus into account two policy relevant aspects: sustainability and vulnerability.

The estimation of the local economic performance

Using a regular grid of 1 km, in the ESPON DB 2013 projects, one of the teams (UAB) successfully disaggregated indicators from NUTS3 level to this new geometry (GDP 2006 and 2003, Unemployment 2006 and 2003 and Active population 2006 and 2003). The output of this methodology served us to better explore two problems:

a) How to re-aggregate data in an intermediary geometry (LAU2 scale)?
b) How to build a homogeneous indicator that covers all the ESPON space?

The first issue was already presented in this report and we have observed that the optimal way to map and use the new indicators is to pass by a smoothing process. The smoothing was already implemented for 4 countries (CZ, SK, HU, RO), in the case of the GDP 2006 indicator. A second attempt was recently made to estimate the local economic performance (based on the GDP 2006 values in a regular grid) for all the countries in the ESPON space (with three exceptions – CH, NO, IS).

The working methodology for this estimation follows several main steps:

1) The grid with the GDP 2006 estimated indicator was split in 31 new features, using the country boundaries as a clip.
2) The new features were intersected with the LAU2 geometry for each state (31 operations)
3) The area of each cell in the new grids was calculated in order to better estimate the value of GDP 2006 that must be allocated to the LAU2
4) The data was summarized using the LAU2 code and merged in a new table that covers the ESPON space.

In this point, several cartographic explorations were made, trying to check if the local economic performance (estimated) is veridical.

Based on the cartographic explorations, there are some issues to signal:

1) The local economic performance estimated for every LAU2 (expressed in millions of EURO for 2006) is strongly depending on the LAU2 area. Theoretically, a bigger LAU2 will be richer than a small one. As an example, this aspect penalizes the French "communes".
2) The transformation of data (a Z score was build to better shape the areas of local economic performance) don't reduce the geometrical effect. However, it privileges the urban areas and the engines of growth.
3) A strong territorial auto-correlation effect is interfering with the map process. This effect is impossible to be reduced, if we take into account the fact that the grid data estimation provided by the UAB team is based on the NUTS 3 values.

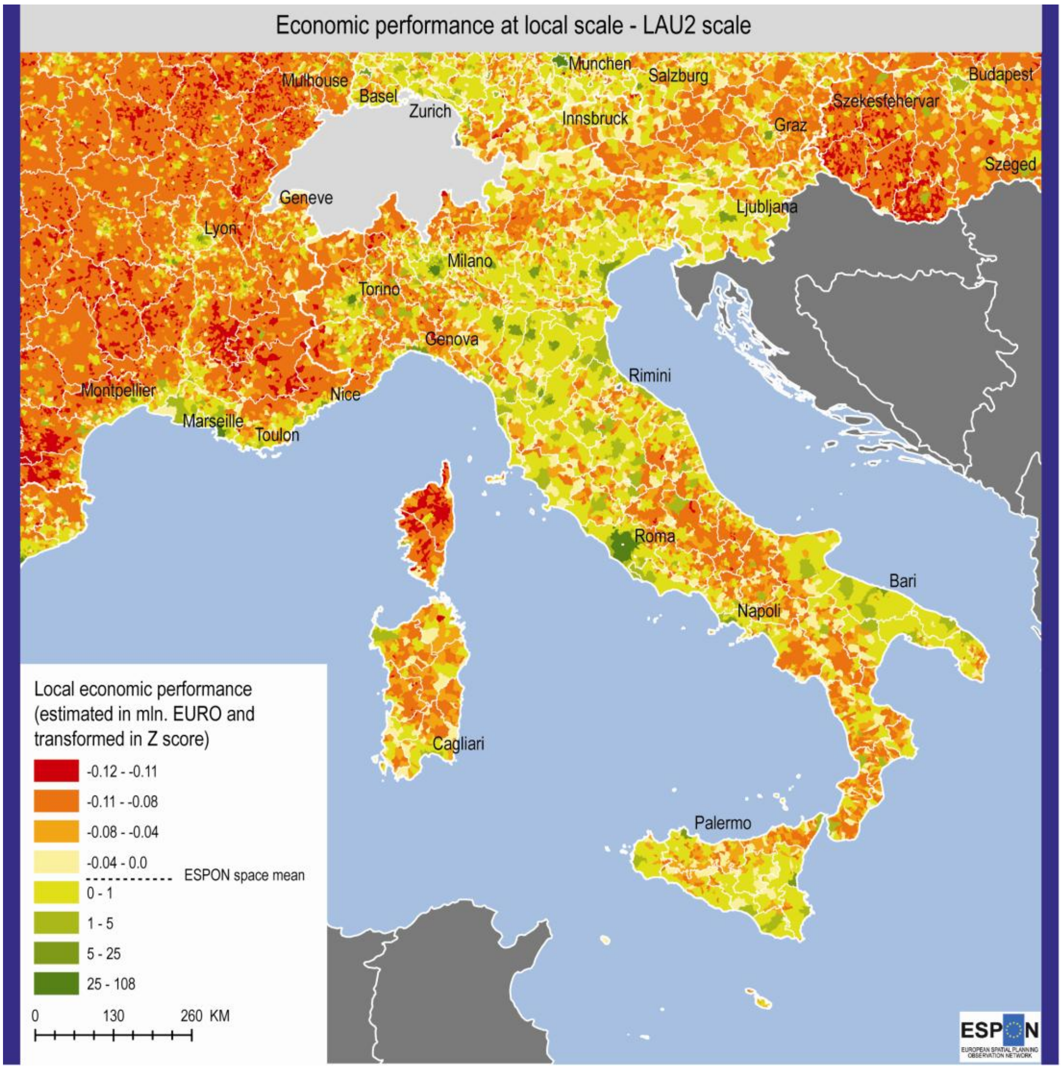

Figure 13 **Local economic performance in 2006 - Italy**

Having these three issues in mind, we have derived a new indicator of local economic performance – the LAU2 values being expressed as a density, in millions of Euro/sq. km. These new values reduce the territorial auto-correlation effect and link the estimated local economic performance to the distribution of population at LAU2 scale (Fig. 14). Probably, a smoothing method applied to these values will compensate all the issues described and will provide a much more interesting indicator. There are some technical limitations to this smoothing method, limitation which are induced by the large number of features that are present in the table and on the map.

Another aspect to signal here is related to the division of the large metropolitan areas in LAU2 polygons (such as Paris or London). Building a top of the economic performance will present some surprises, from this point of view.

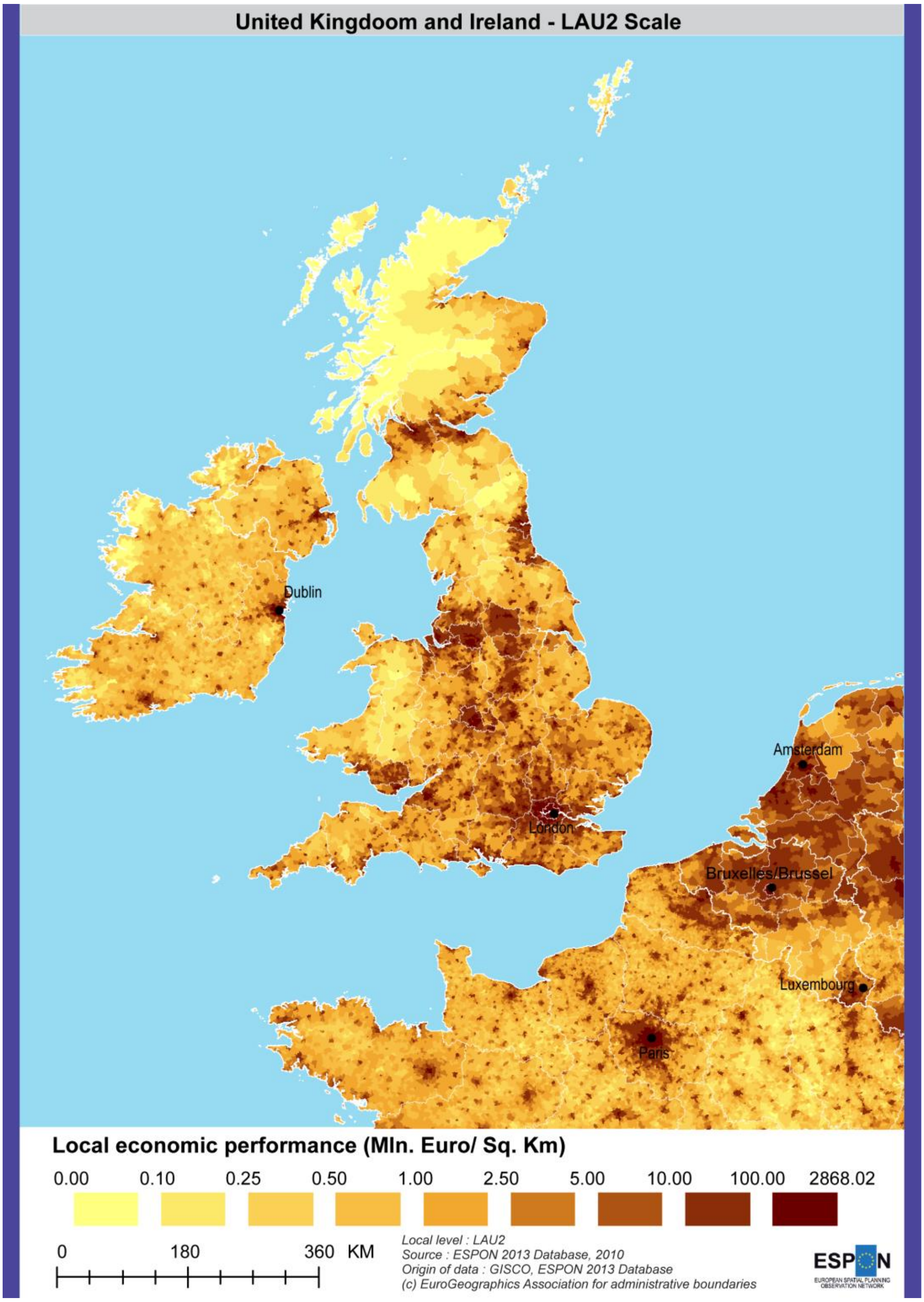

Figure 14 **Local economic performance in 2006 – UK and Ireland**

List of indicators – rank 3 land use categories at LAU2 scale

Indicator	CLC 2006 - LABEL3	CLC 2006 - LABEL1
C111	Continuous urban fabric	Artificial surfaces
C112	Discontinuous urban fabric	Artificial surfaces
C121	Industrial or commercial units	Artificial surfaces
C122	Road and rail networks and associated land	Artificial surfaces
C123	Port areas	Artificial surfaces
C124	Airports	Artificial surfaces
C131	Mineral extraction sites	Artificial surfaces
C132	Dump sites	Artificial surfaces
C133	Construction sites	Artificial surfaces
C141	Green urban areas	Artificial surfaces
C142	Sport and leisure facilities	Artificial surfaces
C211	Non-irrigated arable land	Agricultural areas
C213	Rice fields	Agricultural areas
C221	Vineyards	Agricultural areas
C222	Fruit trees and berry plantations	Agricultural areas
C231	Pastures	Agricultural areas
C242	Complex cultivation patterns	Agricultural areas
C243	Land principally occupied by agriculture, with significant areas of natural vegetation	Agricultural areas
C311	Broad-leaved forest	Forest and semi natural areas
C312	Coniferous forest	Forest and semi natural areas
C313	Mixed forest	Forest and semi natural areas
C321	Natural grasslands	Forest and semi natural areas
C322	Moors and heathland	Forest and semi natural areas
C324	Transitional woodland-shrub	Forest and semi natural areas
C331	Beaches, dunes, sands	Forest and semi natural areas
C332	Bare rocks	Forest and semi natural areas
C333	Sparsely vegetated areas	Forest and semi natural areas
C411	Inland marshes	Wetlands
C412	Peat bogs	Wetlands
C421	Salt marshes	Wetlands
C422	Salines	Wetlands
C511	Water courses	Water bodies
C512	Water bodies	Water bodies
C521	Coastal lagoons	Water bodies
C523	Sea and ocean	Water bodies
CREL111	Continuous urban fabric (share in% at LAU2 level)	Artificial surfaces
CREL112	Discontinuous urban fabric (share in% at LAU2 level)	Artificial surfaces

CREL121	Industrial or commercial units (share in% at LAU2 level)	Artificial surfaces
CREL122	Road and rail networks and associated land (share in% at LAU2 level)	Artificial surfaces
CREL123	Port areas (share in% at LAU2 level)	Artificial surfaces
CREL124	Airports (share in% at LAU2 level)	Artificial surfaces
CREL131	Mineral extraction sites (share in% at LAU2 level)	Artificial surfaces
CREL132	Dump sites (share in% at LAU2 level)	Artificial surfaces
CREL133	Construction sites (share in% at LAU2 level)	Artificial surfaces
CREL141	Green urban areas (share in% at LAU2 level)	Artificial surfaces
CREL142	Sport and leisure facilities (share in% at LAU2 level)	Artificial surfaces
CREL211	Non-irrigated arable land (share in% at LAU2 level)	Agricultural areas
CREL213	Rice fields (share in% at LAU2 level)	Agricultural areas
CREL221	Vineyards (share in% at LAU2 level)	Agricultural areas
CREL222	Fruit trees and berry plantations (share in% at LAU2 level)	Agricultural areas
CREL231	Pastures (share in% at LAU2 level)	Agricultural areas
CREL242	Complex cultivation patterns (share in% at LAU2 level)	Agricultural areas
CREL243	Land principally occupied by agriculture, with significant areas of natural vegetation (share in% at LAU2 level)	Agricultural areas
CREL311	Broad-leaved forest (share in% at LAU2 level)	Forest and semi natural areas
CREL312	Coniferous forest (share in% at LAU2 level)	Forest and semi natural areas
CREL313	Mixed forest (share in% at LAU2 level)	Forest and semi natural areas
CREL321	Natural grasslands (share in% at LAU2 level)	Forest and semi natural areas
CREL322	Moors and heathland (share in% at LAU2 level)	Forest and semi natural areas
CREL324	Transitional woodland-shrub (share in% at LAU2 level)	Forest and semi natural areas
CREL331	Beaches, dunes, sands (share in% at LAU2 level)	Forest and semi natural areas
CREL332	Bare rocks (share in% at LAU2 level)	Forest and semi natural areas
CREL333	Sparsely vegetated areas (share in% at LAU2 level)	Forest and semi natural areas
CREL411	Inland marshes (share in% at LAU2 level)	Wetlands
CREL412	Peat bogs (share in% at LAU2 level)	Wetlands
CREL421	Salt marshes (share in% at LAU2 level)	Wetlands
CREL422	Salines (share in% at LAU2 level)	Wetlands
CREL511	Water courses (share in% at LAU2 level)	Water bodies
CREL512	Water bodies (share in% at LAU2 level)	Water bodies
CREL521	Coastal lagoons (share in% at LAU2 level)	Water bodies
CREL523	Sea and ocean (share in% at LAU2 level)	Water bodies

(Source of labels : CLC 2006 legend ; http://www.eea.europa.eu/data-and-maps/data/clc-2006-vector-data-version/corine-land-cover-2006-classes)