Ulysses

Using applied research results from ESPON as a yardstick for cross-border spatial development

Targeted Analysis 2013/2/10

Annex I – Methodological outline of Task 2.2. -

Multi-scale performance analysis

Version 14/10/2011

EUROPEAN UNION
Part-financed by the European Regional Development Fund
INVESTING IN YOUR FUTURE

Summary

Objectives

The general aim of Task 2.2 is to do a multi-thematic and multi-scale analysis of the different Cross Border Regions.

For this, the regions' behaviour regarding two major dimensions was analysed: territorial profile and territorial performance. The territorial profile refers to indicators of the four major ESPON themes (polycentric development, urban-rural relationship, accessibility & connectivity and demography). The territorial performance refers to their capacity in achieving the Lisbon/EU 2020 and Gothenburg strategy goals. Besides the individual analyses of each topic, these two dimensions were also subjected to a more detailed analysis in order two identify causal relations between them.

Main outputs

- A territorial profile of each CBR, based on the different themes under analysis;
- An evaluation of the territorial performance based on Lisbon/EU 2020 and Gothenburg objective indicators;
- Analysis of the relations between the territorial performance and the territorial profile;
- Analysis of the most relevant drivers that influence the regions behaviour regarding the different themes;
- A methodological report that gives a hint on how to interpret the different outputs.

Main challenges

The main challenge for this analysis was the quality of the data:

- Information is being collected in many different ways across the countries meaning that, although the amount of data is available for each side of the border is often large, data that is comparable is very scarce;
- The inclusion of regions in countries that are outside the European Union and therefore follow criteria that are far from the European norms (Russia and Switzerland);

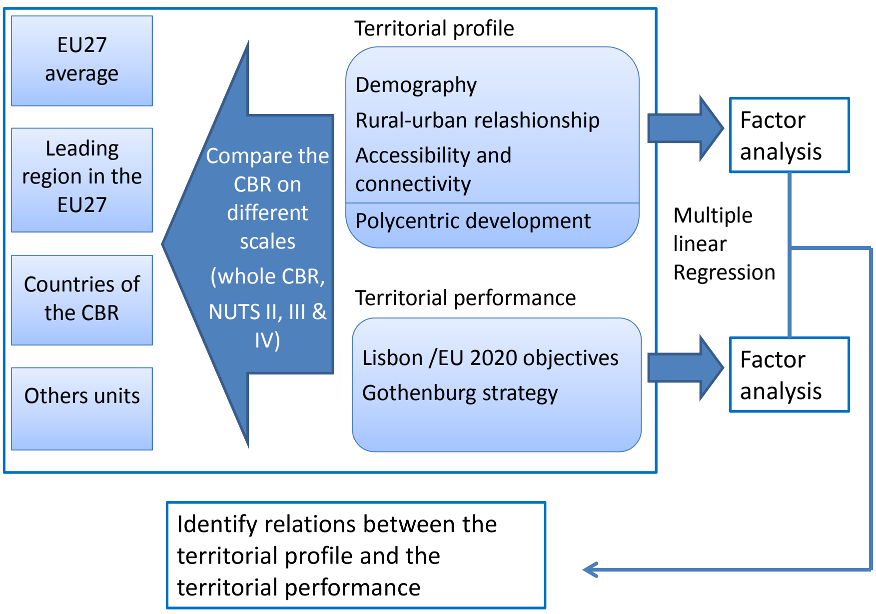
- Many of the more complex indicators that were produces for specific ESPON projects have not been updated and are therefore only available for a no longer prevailing NUTS 3 delimitation (1999 or 2003 versions);
- Some ESPON indicators are based on complex methodologies and, as the metadata is not always explicit on the precise procedure, difficult to interpret;
- Often, the ESPON indicators are better suited for a EU wide analysis then for local or even regional scales.

Contingency methods

- Search for data in different sources (this was forcibly done to a limited extent, as it is very time-consuming);
- Use of different (but similar) indicators for different regions;
- Use of different geographical units;
- Estimate missing data by means of a function that correlates a missing variable with other variables in a large number of similar regions;
- Adapt the interpretation of the results (interpret results as an indication and not a scientifically sound analysis).

Procedure

The analysis followed the following steps:



The **territorial profile** groups indicators that relate the four major themes of the ESPON. It intends to describe the territorial situation of each CBR in the broader context in a clear and synthetic way. The **territorial performance** groups indicators that can be understood as expressing the regions' capacity to reach the Lisbon/EU 2020 and Gothenburg objectives.

Multi-scale analysis

For analysing both dimensions, the indicators of each of the CBR were compared on **different scales**: (1) between different NUTS III (and in some cases NUTS II or IV) of the CBR; (2) between the CBR and the countries to which they belong to; (3) between different NUTS III (and in some cases NUTS II or IV) of the CBR regions belonging to a different country; (4) between different NUTS III (and in some cases NUTS II or IV) of the CBR and a reference index that can be established by the EU27 average, the leading region in the EU27, the individual countries of which the CRB are part or any other reference that might be useful to understanding the regions' performance for a specific indicator (for example, regarding total fertility rates, it is useful to evaluate the regions according to the renewal of their population: total fertility rate of 2,1).

The comparison between different scales had two main purposes. The first one was to understand the regions' behaviour in context, as many indicators are not easy to interpret in absolute terms. The second one was to contribute in understanding the effect of the border on the regions' behaviour. For example, a comparison of one side of the border of a CBR to the national average as well as the other side of the border might help to evaluate whether a region's performance is more influenced by its border position or by the realities of the countries it belongs to.

Factor analysis

The different themes were also be subjected to different statistical analysis in order to identify causal relations between the relative performances of each CBR and the territorial profile, as well as the main drivers behind the different performances.

For this, two different factor analyses were made: one for the territorial profile and one for the performance indicators. These factor analyses were made using data on a NUTS 3 scale for all the EU 27 countries. The polycentricity indicators were excluded, because they are not suited for the NUTS 3 level at which the analysis was performed. Also, and since the intention was to establish a causal relation between general aspects that characterize the regions and their performance, some of the indicators that are typically related to the Lisbon/Europe or the Gothenburg Strategy where included in the first set of indicators. This was the case, for example, for the ESPON climate indicators. These indicators relate the regions' sensitivity to potential climate change (e.g. the amount of flood prone areas) with elements of their spatial layout (e.g. population density, presence/absence of susceptible economic infrastructures). In this sense these indicators do not really reflect a regions capacity in reaching the Gothenburg goals, but are more related to their general exposure which is, to a high extent, a consequence of their geographical position or historic evolution.

Regression analysis

After the factor analysis, several multiple regressions were made, having as independent variables each factor of the performance indicators and as dependent variables all the factors of the territorial profile. Essentially, this analysis distinguished the influence of the regions' characteristics on its capacity to develop itself in a sustainable and cohesive way. But this does not mean that the territorial profile and the territorial performance are not relevant *per se*: the relations between different indicators are not necessarily marked by unique and clear-cut causal relations and relevant indicators of the territorial profile may have no significance to the territorial performance.

1. Demographic Analysis

The main objective of this analysis is to identify the CBR's behaviour regarding demography. Namely, to try to answer the questions: how is the border affecting settlement patterns? are the border regions growing faster or slower than non-border regions? is their population ageing more or less rapidly?

Data

The indicators that were used for this analysis were the following:

Indicator	Geographical scale	Source	Time frame
Population density	NUTS 3, Lau 1/2	EUROSTAT, National Statistical Institutes	2000-2009
Net migration, natural growth, total growth	NUTS 3	EUROSTAT, ESPON DB/Demipher Project	2000-2009
Demographic potential	Lau 1/2	Own calculation	2008
Commuters to other countries by active population	NUTS 2	EUROSTAT	2009
Commuters to other regions by active population	NUTS 2	EUROSTAT	2009
Total fertility rate	NUTS 2	EUROSTAT	1997-2009

Young age dependency rate	NUTS 3	EUROSTAT	2009
Old age dependency rate	NUTS 3	EUROSTAT	2009
Ageing index	NUTS 3	EUROSTAT	2009
Foreigners requesting residents permit	Lau 1/2	National Statistical Institutes	2008

Given the regularity at which demographic indicators are updated (even if through estimations) and that the ESPON demographic indicators are essentially built on EUROSTAT data, the data for demography comes majorly from this source. Data from the Demipher (ESPON) project was also use in order to fulfil occasional data gaps.

Methods

Most of the demographic analysis is based on standard indicators. These indicators essentially refer to the evolution of the population, the cause of this evolution (natural growth, migration rates), the age structure and, when available, commuting data.

Besides the straightforward indicators, two additional analyses were performed for the CBA for which local data and shapefiles were readily available: the impact of the border distance on population growth and the demographic potential. Both of these indicators relate population with distance. Although the distance should ideally be the actual travel time by road, here a simplified version was used based on air distance.

Demographic potential

The capacity of a region to develop itself does not only depend on its intrinsic characteristics but is also a function of its accessibility to other regions (Dentinho 2007). It is therefore important to understand how a region is positioned in the whole network of other regions, namely how far it is from other major poles or densely populate areas. For this analysis, the demographic potential was calculated, whenever population on a LAU 1 and adequate shapefiles where made available.

The demographic potential of a given point i relative to j can be obtained through the following formula:

$$V_j = \sum_j \frac{P_j}{d_{ij}}$$

V_j = potential in j, P_j = population in j and d_{ij} = distance between j e i

The regions' own potential is included by dividing its population by one fourth of its perimeter (calculated through the area of the region and not its actual perimeter). In this case the population and distances between all the Lau 1 of the CBR, as well as the NUTS 3 in the rest of the countries were considered.

Border effect on population growth

There is a common tendency to relate border regions with geographical, demographical and economic remoteness. At a first glance this seems certainly true for some of the CBR (e.g. Extremadura-Alentejo CBR). But what exactly is the border effect on the actual evolution in the settlement patterns? To answer this question a simply relation between demographic growth and border distance is not enough, as population growth it is very dependent on population density.

This means that, in order to actually be able to evaluate whether the population growth is related to the border effect, a function that considers population density as well as the distance to the border was applied. This function can be described by the following formula:

$$Growth\ Rate = A + a_{db}db + a_d d + \varepsilon$$

Where db is the distance to the border of the region's centroid and d is the density of a given region.

2. Policentricity

The main objectives of this chapter are to identify tendencies in the structure of the city network in the CRB: is the urban network more or less dense than in non-border regions? do the amount and size of the urban centres deviate from the rank-size distribution of the ESPON space? if so, in what sense (more polycentric, less polycentric)?

Naturally, the distinction between monocentric or polycentric areas cannot be made area in a dichotomous manner, and polycentricity should be measured by scoring an area with a value ranging from more monocentric to more polycentric.

According to the ESPON 1.1.1, polycentricity has a twofold feature:

- Morphological, laying out the distribution of urban areas in a given territory;
- Relational, based on the networks of flows and cooperation between urban areas at different scales/levels.

While there is some data available regarding morphology, the dynamic aspects of the city systems are very poorly covered. Although some attempts to differentiate FUA according to their functional specialization have been made, the analysis of how the different urban agglomerations articulate themselves and interact with their surroundings cannot be soundly made on a broad scale. Most of the ESPON data therefore focuses on the morphological aspects.

Data

Indicator	Geographical scale	Source	Time frame
Morphological and Functional Urban Areas	CBR	ESPON DB	2006
Slope rank size distribution GDP	CBR, ES, PT ESPON	Own production, based on ESPON DB	2006
Primacy rate GDP	CBR, ES, PT ESPON	Own production, based on ESPON DB	2006
Slope rank size distribution population	CBR, ES, PT ESPON	Own production, based on ESPON DB	2006
Primacy rate population	CBR, ES, PT ESPON	Own production, based on ESPON DB	2006
% population in FUA	CBR, ES, PT ESPON	ESPON DB	2006
% effective FUA pop change	CBR, ES, PT ESPON	ESPON DB	01-06
Compactness (MUApop/FUA pop)	CBR, ES, PT ESPON	ESPON DB	2001
Gini coefficient thiessen polygons (%)	CBR	Own production, based on ESPON DB	2006

The data used here was developed by the ESPON 1.4.3 and is based on the concept of Functional Urban Area (FUA) from the ESPON 1.1.1. The ESPON 1.4.3's intention was to review the ESPON 1.1.1 and to develop a methodology for defining FUA that was independent from national classifications. Their classification is done by identifying a Morphological Urban Area (MUA), which is essentially a cities' core, to which a commuter catchment area is added. The commuter catchment area is made up by adding further LAU 2 if they form a high density continuum. The final definition of whether to consider an agglomeration a FUA also takes into account its total size (please see the final report of the project for a more detailed description). This method has straighten out some inconsistencies in the former FUA definition, by eliminating many small FUA considered by the ESPON 1.1.1 not through a size criterion but by the importance that national experts gave to the FUA in question.

Further characterization of the FUA has also been done considering the data available for the NUTS of which the FUA are part or which they cover entirely.

While this approach guarantees data comparability throughout the ESPON the countries, it has the inconvenience that it only considers urban centres on a broad scale. Small urban centres are simply not taken into account, which makes it difficult to evaluate the urban systems on a national or regional level. The ESPON 1.4.3 also maintains some FUA that have a very small overall population in some countries but not in others, leading to confusion about what exactly the criterion is.

Geographical scale

FUA in the ESPON 1.4.3 are defined by aggregating LAU 2 in a way that they can cover several broader administrative boundaries. Thus, their inclusion in one region or another poses some difficulties when the intention is to evaluate urban systems in confined regions. In this analysis, the FUA were considered to be part of the CBR (defined by NUTS2) if more than 60 % of their area is overlapping with that the CBR or if most of their Morphological Urban Area (MUA) is within the limits of the CBR. The analysis of the urban systems is made on the whole CBR, as the concept of policentricity as understood by the ESPON 1.4.3 is not meaningful on very low geographical scales.

Methods

Besides general aspects, such as the FUA's compactness, growth or numbers, some more specific analysis of the city system were developed. The first one is the **rank-size distribution of the FUA** (1). The second one was is the Gini coefficient of the **FUA's thiessen polygons** (2). And the third one is the analysis of **socio-economic characteristics** (3) of the FUA.

For the **rank-size distribution (1)**, three different procedures were performed. The first one is analyses the slope of the rank size distribution, which measures the overall level of hierarchy. For this indicator, the FUA of the regions are ranked according to their population and then the following equation is estimated:

$$\ln(pop\ or\ GDP) = a + b\ln(rank)$$

The latter is the so-called rank-size equation in the Lotka form. If the estimated relation holds, the size distribution of cities follows a statistical log-linear distribution. The slope of equation, given by the estimated β, indicates the level of hierarchy, and thus the level of polycentricity within a region: the lower the absolute value of estimated β, the higher the level of polycentricity.

The second procedure is comparing the regions' actual and expected FUA. For this exercise, rank-size coefficients are estimated considering the FUA of the whole ESPON countries (EU27 + CH + NO). The actual rank-size distribution of the relevant NUTS 2 is thereafter compared with what would be expected if the regions would follow the European distribution.

Taking the Zipf law:

$n^k P_n = A$

$\ln P_n = \ln A + k \ln n$, where A is the population of the biggest city

it is possible to adjust a regression curve to the population living in FUA in the EU-27 regions plus Switzerland and Norway:

$\ln Pn = A + k \ln n + \varepsilon$

The calculation for all the FUA produced the following parameters for the curve:

$k = -1{,}0521$, which is very close to -1, the value corresponding to the regularity known as Zipf's law.

This equation will be the pattern to which the actual FUA distribution of a given region will be compared. To perform this comparison for a given region i, first the total population of its FUA has to be estimated (PF_i). For this we assume that the weight of the region's FUA population in relation to its total population is equal to the ESPON countries average:

$$PF_i = P_i \frac{PF(UE)}{P(UE)}$$

Second, the PF_i is distributed by n FUA according to the EU pattern:

$PFn = k\, n^{1,0514}$

Where Fn is the FUA of ranking n and k is the population of the biggest FUA.Since k is unknown, it is calculated as the exact value which fits the equation $\sum PF_n = PF_i$.

It is thereafter possible to estimate the amount and size of FUA a CBR should have if it would follow the overall distribution to the actual amount and size of its FUA.

The third procedure was analysing the primacy rates. Primacy rates measure the degree to which the size of the largest city of the cross-border region deviates from the regression line of the rank-size distribution of the regions. If this indicator is above 1, the main city's population is above the value that would be expected according the rank-size distribution of the FUA of the region. If the primacy rate is below 1, the main FUA is smaller than the expected value.

This means that, while regions in which one big city dominates the city system tend to have high primacy rates, the opposite holds true for more polycentric regions.

The largest city is excluded in this exercise in order to avoid that its effect on the equation could influence the results. If, for example, we would have a very large prime city in a small region/country, its weight could lead to a very high coefficient in the rank-size equation and therefore the primacy rate would be small (even though there is a clear dominance of one city over the region/country).

The **Gini coefficient of the thiessen polygons (2)** is a is a measure of how the FUA are spaced throughout the region: number closer to 100% mean greater inequalities in the FUA distribution while lower percentages means the FUA are more evenly spaced. For this indicator, the polygons where produced based on the ESPON 1.4.3 FUA layer (made available by the ESPON DB 2013) so that the limits of the polygons are established exactly midways between two FUA. On a national level, the Gini coefficients were produced considering the border as a limit.

The **socio-economic situation (3)** is based on the ESPON 1.4.3 indicators and includes: unemployment rates, GDP per inhabitant and value added by NACE 1.1. These indicators were obtained by crossing the NUTS 3 values which that of the FUA that do partly or totally cover them. They are therefore broad approximations that should be read with some care.

3. Urban-rural relationship

The original objectives of this chapter were to identify relations between urban centres and their rural hinterlands: how are different population densities related to land use patterns? is the urban-rural typology capable of explaining different evolutions in land consumption? how are these categories linked to the economic structures?

Data

Although the urban-rural relationship has been subjected to some study, namely in the ESPON program, there still is no data available on the EUROSTAT or the ESPON to actually evaluate the interaction between rural and urban areas (meaning the flow of people and goods as well as computer mediated communications).

The focus in this chapter was therefore on structural indicators, such as land use patterns and economic sectors. But, even if it is possible to get land cover data on a very low geographical scale from the Corine Land Cover, indicators such as employment and economical patterns are only available at a NUTS 3. The typologies established by the ESPON and by the Eurostat, are also only available at a broad scale, limiting the ability to link the indicators with rural or urban classifications any significant dimension. The focus in this chapter was therefore on the urban-rural typologies on a NUTS 3 level, highlighting some of the differences between the regions concerning the structural indicators.

The used indicators were the following.

Variable name	Geographical scale	Source	Time frame
Change urban fabric	NUTS 3	Own production, based on the CLC	2000-2006
Agricultural areas	NUTS 3	ESPON DB	1990; 2000; 2006
Urban-rural typology	NUTS 3	ESPON DB/ Eurostat	
Urbanization of natural areas	NUTS 3	Own production, based on the CLC	2000-2006
Gross value added in forestry and fishing	NUTS 3	Eurostat	1997-2008
Employment in forestry and fishing	NUTS 3	Eurostat	1997-2008

Typologies

The ESPON 1.1.2 typology regarding urban and rural regions is based on tree indicators: land cover, population density and the presence/absence of a FUA. According to different combinations of these indicators, NUTS 3 have been classified as having high or low human influence (population densities) and urban intervention (land cover). Although it has been included for illustrative purposes, this typology has not been use to cross with other data. The reason for this is twofold: 1) the indicator has not been updated for NUTS 3 changes; 2) the inclusion of indicators on land cover to establish the typology would lead to confusing when trying to cross these indicators with the typology.

The urban rural typology that was mainly used was a revision by the EUROSTAT of the OECD typology. This typology is established in tree steps:

1. The first on is to clusters urban grid cells with a minimum population density of 300 inhabitants per km2 and a minimum population of 5 000. All others are considered rural.
2. The second one is to group NUTS 3 regions with less than 500 km2 with some of its neighbours solely for classification purposes, i.e. all the NUTS 3 regions in a grouping are classified in the same way.
3. The third one is to classify the NUTS 3 regions based on the share of population in rural grid cells. All that have more than 50 % of the total population in rural grid cells are

considered predominantly rural. All between 20 % and 50 % in rural grid cells are considered to be intermediate. And all with less than 20 % in rural cells are considered to be predominantly urban (Eurostat 2010: 249).

Further, some regions that are predominantly rural are considered intermediate in the presence of a city with more than 200 000 inhabitants and intermediate regions with cities of over 500 000 inhabitants are considered as urban.

4. Accessibility and connectivity

The main goal of this chapter is to evaluate the accessibility and connectivity levels of the CBR. The more specific questions to be answered are how are general accessibility levels of the CBR regarding different modes of transportation? what is their communication infrastructure like?

Data

Most of the data for accessibility available at the ESPON database is very outdated and available mostly for the 1999 NUTS version. The use of NUTS 1999 delimitations is specially limiting since changes in the coding systems and the actual boundaries of the regions have occurred in almost all of the countries in Europe. Nonetheless, the potential accessibility by different modes of transportation has been updated in 2006 and re-calculated for fitting the then ruling NUTS 3 delimitation retroactively for 2001 and is therefore available for two comparable years. This is particularly useful as this indicator does not limit itself to measuring the transport network, but synthesizes the overall accessibility of the regions by relating the travel time (impendence function) with the population that can be reached (activity function).

As for connectivity, there is normally a great lack of information. Even straightforward indicators, such as internet connections by household, are often difficult to come by, as the Internet Service Providers are reluctant to share this type of strategic information. Another issue is that the data is often not disaggregated at the regional level, only allowing international comparisons. Therefore, only two indicators on connectivity were included in this report: a composite indicator on the internet infrastructure was collected from the ESPON database and the percentage of households with broadband internet connection from the 5th Cohesion Report.

Variable name	Geographical scale	Source	Time frame
Potential accessibility road, rail, air indexed to ESPON average	NUTS 3	ESPON DB	2001;2006

Potential accessibility road, rail, air indexed to CBR average	NUTS 3	ESPON DB	2001;2006
Potential accessibility road, rail, air index change 2001-2006	NUTS 3	ESPON DB	2001;2006
Households with broadband connection	NUTS 2	European Comission 5th Cohesion	2009
Composite indicator on the Internet infrastructure	NUTS 2	ESPON DB	2008

Methods

Accessibility is forcefully a relative concept: a region's accessibility is not and inherent trait, but a consequence of its relative position in the broader territory. As Walter Hansen puts it, "accessibility is a measurement of the spatial distribution of activities about a point, adjusted for the ability and the desire of people or firms to overcome spatial separation" (Hansen,1959:73).

In the ESPON 1.2.1 Final Report, the potential accessibility is an indicator that relates the activities to be reached with the travel time it takes to reach them. Its function is as follows:

$$A_i = \sum_j W_j^a \exp(-\beta c_{ij})$$

where A i is the accessibility of area i, Wj is the activity W to be reached in area j, and c ij is the generalised cost of reaching area j from area i. Ai is the total of the activities reachable at j weighted by the ease of getting from i to j. The interpretation is that the greater the number of attractive destinations in areas j is and the more accessible areas j are from area i, the greater is the accessibility of area i." (ESPON 2006: 276)

For each NUTS 3 of the ESPON space the potential accessibility was obtained by relating the travel time between the centroids through different modes of transportation with the population (road, train and air). Regarding the travel time by air, the exact methodology wasn't available at the metadata of the ESPN DB or the ESPON project's final report, but other modes of transportation are forcefully included.

The multimodal accessibility has also been calculates as an overall indicator that synthesizes all the different modes. According to the ESPON project, multimodal accessibility is "a logsum accessibility potential aggregating over road, rail and air" Ibid: 131. This essentially means that the individual accessibilities are aggregated in a way that balanced regions will have greater multimodal accessibilities than regions with very high results in some modes and very low results in others.

As the potential accessibility was produced for two different years, it is possible to see the evolution of the infrastructure in this period. Here, the index change of accessibility was used. For this indicator, “the accessibility values of 2001 are standardised to the ESPON average of that year and those of 2006 to the average of that year, each ESPON average is set to 100 and the regional values are transformed accordingly. The map then shows the differences of the index values, i.e. the change of the position of the regions relative to other regions. Positive values express an improvement of the relative locational quality, while negative values express a loss in relative locational quality” (Spiekermann & Wegener 2007: 9).

5. Gothenburg and Lisbon/Europe 2020 strategy

The main objective of this chapter is to measure the regions’ performance regarding the Gothenburg and Lisbon/Europe 2020 Strategy goals.

The common framework set for the future development of the European Union is essentially based on three pillars: an economic one, a social one and an environmental one (added to the original goals of the Lisbon Strategy by the Gothenburg Council in 2001). In the centre of these three pillar is the often cited goal of making the European Union “the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion” (Lisbon European Council conclusions, March 2000). The pursuit of this goal is envisaged through a broad set of reform which range from the labour market to the Green House Gas emissions.

Data

In order to monitor how the different countries are adapting themselves to the goals of this strategy, a battery of indicators has been agreed to by the member states for each of these main pillars. This battery of indicators has been used as a reference in this chapter, although changes were made for two reasons. The first one was that not all the indicators that have been selected at the national level are available at the regional one (e.g. energy intensity of the economy, greenhouse gas emissions). The second, was that some other indicators are available that are helpful in shedding a light on the regions’ capacity for developing itself in a sustainable way.

For analytical purposes, these indicators were divided into four different categories: economy and employment, innovation and research, social cohesion and environment.

Variable name	Geographical scale	Source	Time frame
Economy and employment			
GDP per capita Catching up analysis Indexed to leader Coefficient of deviation	NUTS 3	EUROSTAT, Russian Statistical Institute	1997-2009
Gross value added by NACE	NUTS 3	Eurostat	1997-2008
Employment by NACE	NUTS 3	Eurostat	2000-2008
Innovation and research			
GERD, HERD, BERD	NUTS 2	Eurostat	2007
Employment in medium and hich tech manufacturing	NUTS 2	ESPON DB (Regional Innovation Scoreboard)	2004
EPO Patents by per million of inhabitants	NUTS 2	Eurostat	2007
Social cohesion			
Long term unemployment	NUTS 2	Eurostat	2009
Unemployment rate	NUTS 3	Eurostat	2010
Youth unemployment rate	NUTS 3	Eurostat	2010
Population at risk of poverty after social transfer	NUTS 3	Eurostat	2008
Environment			
Share of Natura 2000 areas	NUTS 3	European Commission's 5th Cohesion Report	2009
Solar energy resources	NUTS 3	EC 5th Cohesion Report	1981-1990
Wind energy potential	NUTS 3	EC 5th Cohesion Report	2000-2005
Ozone concentration exceedances	NUTS 3	EC 5th Cohesion Report	2008
Urban waste water treatment	NUTS 2	EC 5th Cohesion Report	2007
Soil sealed area	NUTS 3	EC 5th Cohesion Report	2006
Regional sensitivity to climate change (cultural, economic, environmental, cultural)	NUTS 3	ESPON DB	1961-1990; 2071-2100

Methods

Besides the direct interpretation of the indicators, some calculations were performed to give further insights regarding economic performance and inequalities. The environmental data of the ESPON Climate project also needs some methodological clarification, as it is obtained in a rather complex way.

Economic performance and inequalities

The analysis of the regions' wealth was made from a threefold perspective: to evaluate the regional inequalities in wealth distribution; to point out the regions' actual position in the European context; to understand their relative performance over the last decade. The data used for this analysis was the GDP per for the years 1997 and 2008.

The **regional disparities** were evaluated by the coefficient of deviation of the GDP per capita. This indicator is obtained by calculating the ratio of the standard deviation to the mean, and therefore a good way to compare the distribution of geographical units which differ greatly on their average. As a reference the coefficient of deviation was included for the countries of which the CBR is part as well as for the whole NUTS 3 and NUTS 0 of the ESPON space (EU7+CH+NO for the N0 and only EU7 for NUTS 3).

$$Coefficient\ of\ deviation = \frac{Standard\ deviation}{Average}$$

The **regions' position and performance** was evaluated by two procedures:

A1- To compare each NUTS III with the leader, in terms of GDP per capita, trough index numbers;

A2- to establish the relative performance of each NUTS III to the leading region, exploring the notion of territorial catching-up.

In theory, for both analyses, A1 and A2, the value of reference for GDP per capita would be the highest value among all NUTS III, pertaining to the Inner London West region. However, at this territorial level, GDP per capita can be affected by several factors, such as high population fluctuations and significant mismatches between jobs (and wealth production) and the place of residence. In fact, in economically central places (for which London is a good example), there normally is a steady flow of migrant workers, as well as commuters from other NUTS III, and so the GDP per capita of the economic centre is seriously overestimated. For that reason, instead of simply considering the GDP per capita of the Inner London West NUTS III, the whole Greater London NUTS II was used as a reference for this analysis. The results are presented bellow and the mathematical operations can be analyzed in the annexed Excel file.

A1 – GDP indexed to the leading region

This analysis involves the indexation of GDP per capita in each NUTS III to the value of the leading region in 2008 referred to above, which is by definition 100,0. The concerned computation is represented in the following expression:

$$Index\ GDP_a = \left(\frac{GDP_a}{GDP_L}\right) \times 100$$

where GDP_a is the GDP per capita of a given NUTS III and GDP_L is the GDP per capita of the London NUT II.

A2 - Catching up analysis

This analysis intends to evaluate the speed of catching-up with the leading region, through a standard logistic process. In the present exercise the catching-up process analysis sets the relative position of each NUTS III and its relative trajectory up to the level of 95% of the GDP of the leading region in 50 years. The difference of performance of each region in comparison to the leading region is, in the present analysis, measured in years needed to reach the level assumed above.

According to these assumptions, the logistic function which describes the problem is represented as follows:

$$X = 0{,}95\,\bar{X} = \frac{\bar{X}}{1 + ke^{-at}} \qquad (1)$$

As in the former case, all regions with a performance 95% or higher when compared to the leader region where considered leading regions. The analysis distinguishes converging from diverging regions, and the different levels of catching-up performance. Leading regions are the ones who already have a GDP close to that of the London NUTS 2. Fast converging regions have a growth rate which allows them to reach the leader in no more than 20 years, steady catching-up regions between 21 and 50 years, slow catching-up regions between 51 and 100 and slow converging between 101 a 250 years. Non converging region have great distances in terms of GDP and are growing at a rate equal or slightly superior to the leader and diverging regions are growing less than the leader.

Environment

For the environmental analysis, two sets of indicators are available. On one hand, the indicators from the European Commission's 5th Cohesion Report. And on the other hand, indicators from the ESPON Climate Project regarding the region's sensitivity for climate change.

While the environmental data from the 5th Cohesion Report is easily understood the data of the ESPON Climate project is obtained through a fairly complex methodology. The indicators that were used here are the regions sensitivity to climate change.

The sensitivity is defined by the project as being the "degree to which a system is affected, either adversely or beneficially, by climate related stimuli" (pp.4). The climate change data was obtained from the CCLM climate model, which compare the future period 2071-2100 to the reference period 1961-1990 for the scenario A1B.

The combination of the different impacts the climate change has on a regional level, comes from relating these impacts on characteristics of the affected areas. For physical sensitivity, the amount of buildings and infrastructures that as susceptible to extreme weather events (such as to river floods and coastal storm surges) were considered. Social sensitivity relates the positive or negative effects on human populations. The economic sensitivity considers the impact on economic activities that are strongly dependent on climate conditions (especially tourism and energy). Environmental sensitivity focuses on entities that are highly sensitive to climate changes, such as sensitive soils or protected areas. And cultural sensitivity considers the impact on assets like museums and internationally recognised historic sites.

www.espon.eu

The ESPON 2013 Programme is part-financed by the European Regional Development Fund, the EU Member States and the Partner States Iceland, Liechtenstein, Norway and Switzerland. It shall support policy development in relation to the aim of territorial cohesion and a harmonious development of the European territory.