Ulysses

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

Targeted Analysis 2013/2/10

Annex V – Case Study 3: Greece - Bulgaria Cross-Border Area

Report on Task 2.2 - Multi-scale performance analysis

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Nomenclature

Gross Added Value: A measure of the value of goods and services produced in an area, industry or sector of the economy.

NUTS: Abbreviation of the Nomenclature of Units for Territorial Statistics. It represents a ‘geocode standard’ for referencing the subdivisions of EU space for statistical purposes.

NUTS 1: First level definition of the EU space, corresponding to countries.

NUTS 2: Second level definition of the EU space, corresponding to regions (peripheries for Greece and planning regions for Bulgaria).

NUTS 3: Third level definition of the EU space, corresponding to districts (prefectures for Greece and oblasts for Bulgaria).

NUTS 4: Fourth level definition of the EU space, corresponding to municipalities.

Population Growth: Represents the change of total population over a certain time period.

Population Density: Represents a key geographic parameter expressing the total population per unit area, usually per sq km.

Total Dependency Ratio: Represents the ratio of the combined youth and senior population to the working-age population.

Total Fertility Rate: Represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates.

Executive Summary

The present report comprises a multi-scale and multi-thematic analysis to assess territorial soscioeconomic dynamics and performances of the Greece – Bulgaria Cross-Border Area (CBA) and identify territorial drivers and profiles. The CBA extends at the NE part of Greece and the S part of Bulgaria, consisting of three administrative regions: Yugozapaden (BG41), Yuzhen tsentralen (BG42) and Anatoliki Makedonia, Thraki (GR11). CBA's total population represents approximately 0.85% of EU27 population, decreasing during the latest decade by 4.3%, due to both natural causes and net migration. Xanthi and Sofia stolitsa are the only areas of the CBA experiencing population growth, at even higher rates than EU27 growth rate. Increase in former area is attributed to net migration, while in the latter area to natural increase. Population decrease is mostly attributed to the low mean fertility rate recorded in the CBA. Although fertility rate gradually increases over the latest decade, its value appears significanty lower than the corresponding EU27 rate. Anatoliki Makedonia, Thraki exhibits the highest fertility rate in the CBA, of similar order to the EU27 value. At the same time, the area depicts an over-aging behavior, having higher aged-population share as compared to the young population of the CBA. Population distribution is rather similar to the EU27 mean vaule, but shows strong disparities among NUTS3 areas, with higher population densities near urban conglomerates. Along well-established transportation axes, the border seems to attract population, affecting its density and growth patterns. On the contrary, newly opened crossings do not seem to affect borderline settlements.

Sixteen Functional Urban Areas exist in the Greece – Bulgaria CBA, with Sofia (stolitsa) being the main urban centre dominating the region. Over the years, Sofia's population primacy appears increasing, although the CBA exhibits a rather polycentric pattern in its population distribution. Overall, the population primacy of Sofia over the rest FUAs of the CBA is rather moderate and significantly lower than the corresponding Athens and Thessaloniki primacy over Greece and Voreia Ellada, respectively. On the other hand, Sofia's economic primacy over the remaining CBA is weak to moderate, implying a more polycentric economic development over the cross-border territory. When examining the settlements' relative distance and structure over the CBA, it occurs that most areas are considered as polycentric over their region of influence, and only Sofia, Pernik, Plovdiv, Asenovgrad and Pazardzhik could be characterised as monocentric. Accessibility characteristics of the CBA suggest that most FUAs exhibit limited accessibility changes, as a result of population change. Again, Sofia is the dominant FUA in terms of accessibility over the remaining CBA, with all other areas displaying a rather homogeneous pattern.

Urban-rural analysis involved the identification of CBA's NUTS3 areas according to population density, urban-to-rural population shares, employment and GVA produced by the primary sector and land type coverage. Population density decreases over the latest decade, due to strong depopulation, with projections forecasting that by year 2020 the CBA would be considered as a 'strongly rural area'. Sofia stolitsa is the only 'strongly urban area' of the CBA while Plovdiv the only 'moderately urban area'. Over the last five years a gradual increase in urbanism has occurred in the CBA, mostly shown by the sharp decrease of population employed in Agriculture, Forestry and Fishing sector and its produced GVA. Anatoliki Makedonia, Thraki shows the highest drop in these indicators, following the general national trend. This 'urbanization' tendency of the CBA is also accompanied by a subsequent transformation of agricultural areas into artificial areas. Following the existing Eurostat typology on urban-rural characterization, Sofia stolitsa (BG411) is classified as a 'Predominantly Urban Area'; Kyustendil (BG415), Pernik (BG414), Plovdiv (BG412) and Haskovo (BG422) as 'Intermediate Areas', and all remaining regions as 'Predominantly Rural Areas'. According to ESPON 1.1.2 typology the whole Anatoliki Makedonia, Thraki (GR11) and the regions of Blagoevgrad (BG413), Smolyan (BG424) and Kardzhali (BG425) are areas of 'Low Urban Influence and Low Human Intervention'; Haskovo (BG422), Pazardzhik (BG423), Sofia (BG412) and Pernik (BG414) are characterised as areas of 'Low Urban Influence and Medium Human Intervention', while Sofia stolitsa (BG411) and Plovdiv (BG412) are considered as areas of 'High Urban Influence and High Human Intervention'.

Accessibility and connectivity analysis was performed aiming to determine the general accessibility levels of the Greece – Bulgaria CBA according to the various transportation modes, i.e., road, rail and air, as well as multi-modally. potential accessibility by road of Yugozapaden (BG41) and Yuzhen tsentralen (BG42) (34.38 and 32.56, respectively) appeared significantly higher than that of Anatoliki Makedonia, Thraki (GR11, 21.6), although the latter shows strong infrastructure improvement. Sofia stolitsa (BG411), Plovdiv (BG421) and Haskovo (BG422) acquired the highest potential accessibility by road indices, while Evros (GR111) and Drama (GR114) the lowest. A similar pattern to road accessibility was also shown in the potential accessibility by rail index. Sofia stolitsa (BG411) and Pernik (BG414) show the highest potential accessibility score, while Evros (GR111), Kardzhali (BG425) and Kyustendil (BG415) demonstrate the lower values. Yugozapaden (BG41) depicts the higher potential accessibility by air, almost double than that of Anatoliki Makedonia, Thraki (GR11) and Yuzhen tsentralen (BG42). The multimodal index of Yugozapaden (BG41) appeared significantly higher than the remaining area. Rodopi (GR113) and Kyustendil (BG415) experienced the strongest accessibility improvement, mostly attributed to rail accessibility upgrading. Improvement in the remaining Yugozapaden seems related to air accessibility change. Intermediate improvement is seen in the remaining Yuzhen tsentralen (BG42), mostly attributed to rail and air accessibility changes. Finally,

only Kardzhali (BG425) showed an opposite behaviour, due to negative change in road and rail accessibility indices and the limited air accessibility improvement.

The territorial performance of the Greece – Bulgaria CBA according to the Lisbon/Gothenburg indicators was examined, focusing on the sectors of economic growth, employment, research and innovation, economic reform, social cohesion and the environment. Indexed GDP per capita analysis reealed that the CBA could be characterised as 'less developed to very laggard region', scoring at the low level rankings of EU27 areas. Convergence analysis demonstrated that Kavala (GR115), Xanthi (GR112) and Evros (GR111) are 'non-converging areas', in terms of GDP per capita trends. Kyustendil (BG415), Rodopi (GR113) and Drama (GR114) are considered as 'slow converging areas', while Sofia stolitsa (BG411), Pernik (BG414) and Smolyan (BG424) are considered as 'steady catching-up areas'. Employment in the CBA seems distributed rather evenly among all NACE economic activities, exhibiting a slight annual rise of 0.73% over the last decade. This increase seems attributed to the cosntruction and the financial and reals estate sector. The reduction in the employment in the primary sectors is apparent. Wholesale and retail trade, tourism and transport sector, among with the financial and real estate sector are the higher contributers to CBA's GVA. Construction and public administration services increased their shares over the latest decade. Social cohesion indicators, as total, long-term and youth unemployment rates are generally higher than the corresponding mean EU27 values. Similarly, the Population at Risk of Poverty Index is well above the EU27 level, and only infant mortality seems coparable to the correspondent EU27 standard. All social cohesion indicators gradually improved during the 1997-2008 period. After 2008, due to the global financial crisis, all indicators degrated sharply, returning back to the 1997 levels.

Territorial profile analysis revealed that the lack of central CBA's location over the EU27 space is a major disadvantage. Demographic trends are negative, mostly due to natural causes rather than immigration rates. Trade, tourism and transport are the main economic sectors supporting local CBA's economy. Anatoliki Makedonia, Thraki (GR11) could be identified as a public administration centre of the CBA, in terms of employment and the GVA produced. The area lacks investments in the R&D sector, while appears as rather sensitive to climate change and environmental risks. Territorial performance analysis of the CBA indicated that the area suffers from high unemployment (especially in Anatoliki Makedonia, Thraki) and limited economic development, showing a strong convergence tendency of all Bulgarian areas. Overall, area's poor economic performance seems related to its low centrality, the exaggerated public administration sector, the low R&D investments and the limited demographic dynamism.

Chapter 1. Report Objectives and General Overview

1.1. ULYSSES Objectives in the context of this Report

ULYSSES is a Case Study oriented project, which has as main aim to use ESPON applied results as a yardstick for decentralized cross-border spatial development planning. Four are the overall objectives of ULYSSES:

- Promote ESPON research results, by raising the awareness among involved stakeholders on the practical utility of decentralised cross-border spatial development,
- Produce multi-thematic territorial analysis for the cross-border areas by making use of available ESPON applied research results and other local analyses / data, taking into consideration future territorial challenges,
- Promote experience and best practices exchange in the field of cross border spatial development, by applying coherent cross-border strategies, and
- Promote a further application of targeted research results in the selected Cross Border Cooperation (CBC) areas and review the general usefulness of applied research results in the context of cross border spatial development.

More specific objectives of ULYSSES are:

- Multi-scale and multi-thematic territorial analysis: To analyse the territorial socioeconomic dynamics and performances of each Case Study region with regards to six targeted themes under analysis and different territorial scales. The objective is to identify the territorial drivers and dynamics.
- Institutional performance analysis: To identify key institutional drivers that could allow building better baseline strategies in order to answer main challenges identified.
- Integrated analysis: To make an integrated analysis of the territorial performance and dynamics and the institutional performance, relating the performance analysis with the policy structures and actions.
- Policy recommendations: To formulated strategic guidelines to cope with identified challenges in each cross-border areas, methodological guidelines for future cross-border analysis and policy recommendations at national and EU level that encourage cross-border area territorial cooperation.

The Case Studies to be examined within the framework of ULYSSES are:

- CS 1: The Upper Rhine cross-border area along the land borders between France, Germany and Switzerland,
- CS 2: The cross-border area along the entire Spanish-French land border (Pyrenees),
- CS 3: The cross-border area along the land border between Greece and Bulgaria,
- CS 4: A cross-border area covering parts of the Northern Finland-Russian land border (Karelia),
- CS 5: A cross-border area along the borders between Poland, Germany (land border) and Sweden (maritime border), and
- CS 6: Extremadura/Alentejo (ES/PT).

This Report is referring to Greece – Bulgaria Cross-Border Area (CS 3) and is part of Task 2.2 entitled "Multi-scale Performance Analysis". The main aim of this task is the identification of territorial socioeconomic dynamics and performances for the Greece – Bulgaria Cross-Border Area, with regards to six targeted themes under analysis and under different territorial scales.

Based on a series of data indicators developed by ESPON and other data sources, for each case study CBA, a **territorial socioeconomic dynamic analysis** will take place. This analysis will be done under different territorial scales, thus comparing each region to the cross border area as a whole, each region to the entire cross border area within the same country, each region to the whole cross border area in the neighbouring country and each region confining non-border regions within the same country.

The selected indicators to be used for the analysis of territorial socio-economic dynamics are:

- for the demographic analysis,
  - Total Population (absolute values)
  - Population by sex and age structure
  - Population growth and Projections
  - Total Fertility rate
  - Population density
  - Dependency ratios

    - Border Effect
- for the cross-border polycentric development analysis,
    - Population and GDP in Functional Urban Areas
    - Population and GDP Primacy Rate
    - Location Index of FUAs
    - Connectivity Index of FUAs
    - Overall Polycentricity Index
- for the urban-rural relationship analysis,
    - Population Density
    - Proportions in Urban – Rural Population
    - Employment and produced GVA from Agriculture, Forestry and Fishing
    - Land Use and Land Cover in terms of Artificial area, Agricultural area, Forest area, etc.
    - Relative rurality based on Eurostat and ESPON typology
- for the accessibility & connectivity analysis,
    - Potential accessibility by road, rail and air & multimodal (NUTS 3, 2006)
    - Index change in potential accessibility by road, rail and air & multimodal
    - Households with broadband internet access (NUTS 2)

Based on a series of data indicators developed by ESPON and other data sources, for each case study CBA, a **territorial performance analysis** will take place. This analysis will be done under different territorial scales, thus comparing each region to the cross border area as a whole, each region to the entire cross border area within the same country, each region to the whole cross border area in the neighbouring country and each region confining non-border regions within the same country.

The selected indicators to be used for the Gothenburg and Lisbon 2020 analysis of territorial performance are:

- for the economy & employment analysis,
    - Employment by NACE
    - GDP in million euro
    - GDP in million euro per inhabitant
    - GDP in millions euro of Purchasing Power Parities

    - Employment rate by sex
    - Economically active population
- for the innovation & research analysis,
    - Population by age groups and educational level
    - R&D as % of investment
    - Human resources in Science and Technology as % of total employment
    - % of population with tertiary education
    - % of 18 years old participating in education
    - Patent registration by million inhabitants
- for the social cohesion analysis,
    - Expenditure in euro per inhabitant on sickness and health
    - At risk of poverty after social transfers
    - Long-term unemployment rate
    - Youth unemployment rate
- for the environmental analysis,
    - CO_2 emissions
    - Greenhouse gases emissions
    - Emissions of acidifying substances
    - Number of observed forest fires
    - Occurrence of landslides
    - Occurrence of snow avalanches
    - Regional average number of flood events
    - Energy inland consumption renewable sources
    - CO_2 per capita
    - Number of observed forest fires/1000 sq km in NUTS3 region

Figure 1. Map of NUTS2 level units of the Greece – Bulgaria CBA.

1.2. General Overview of the Greece – Bulgaria CBA

The Greece (GR) – Bulgaria (BG) Cross-Border Area (CBA) is defined by the 494 km borderline length between the two countries. The Greece – Bulgaria CBA is located at the north-eastern part of Greece and the southern part of Bulgaria (Map 1). It comprises of three NUTS2 administrative regions (Figure 2):

- Yugozapaden, (BG41),
- Yuzhen tsentralen (BG42), and
- Anatoliki Makedonia, Thraki (GR11),

Each NUTS2-level is further divided into a number of NUTS3 level administrative districts (Table 1): 6 and 5 NUTS3 administrative districts (oblasts) in Yugozapaden and Yuzhen tsentralen regions, respectively, and 5 NUTS3 administrative districts (prefectures) in Anatoliki Makedonia, Thraki (Figure 2).

Table 1. Administrative levels of Greece – Bulgaria CBA.

	CODE	NUTS-ID
Bulgaria	BG	NUTS1
Yugozapaden	BG41	NUTS2
Sofia (stolitsa)	BG411	NUTS3
Sofia	BG412	NUTS3
Blagoevgrad	BG413	NUTS3
Pernik	BG414	NUTS3
Kyustendil	BG415	NUTS3
Yuzhen tsentralen	BG42	NUTS2
Plovdiv	BG421	NUTS3
Haskovo	BG422	NUTS3
Pazardzhik	BG423	NUTS3
Smolyan	BG424	NUTS3
Kardzhali	BG425	NUTS3
Greece	GR	NUTS1
Anatoliki Makedonia, Thraki	GR11	NUTS2
Evros	GR111	NUTS3
Xanthi	GR112	NUTS3
Rodopi	GR113	NUTS3
Drama	GR114	NUTS3
Kavala	GR115	NUTS3

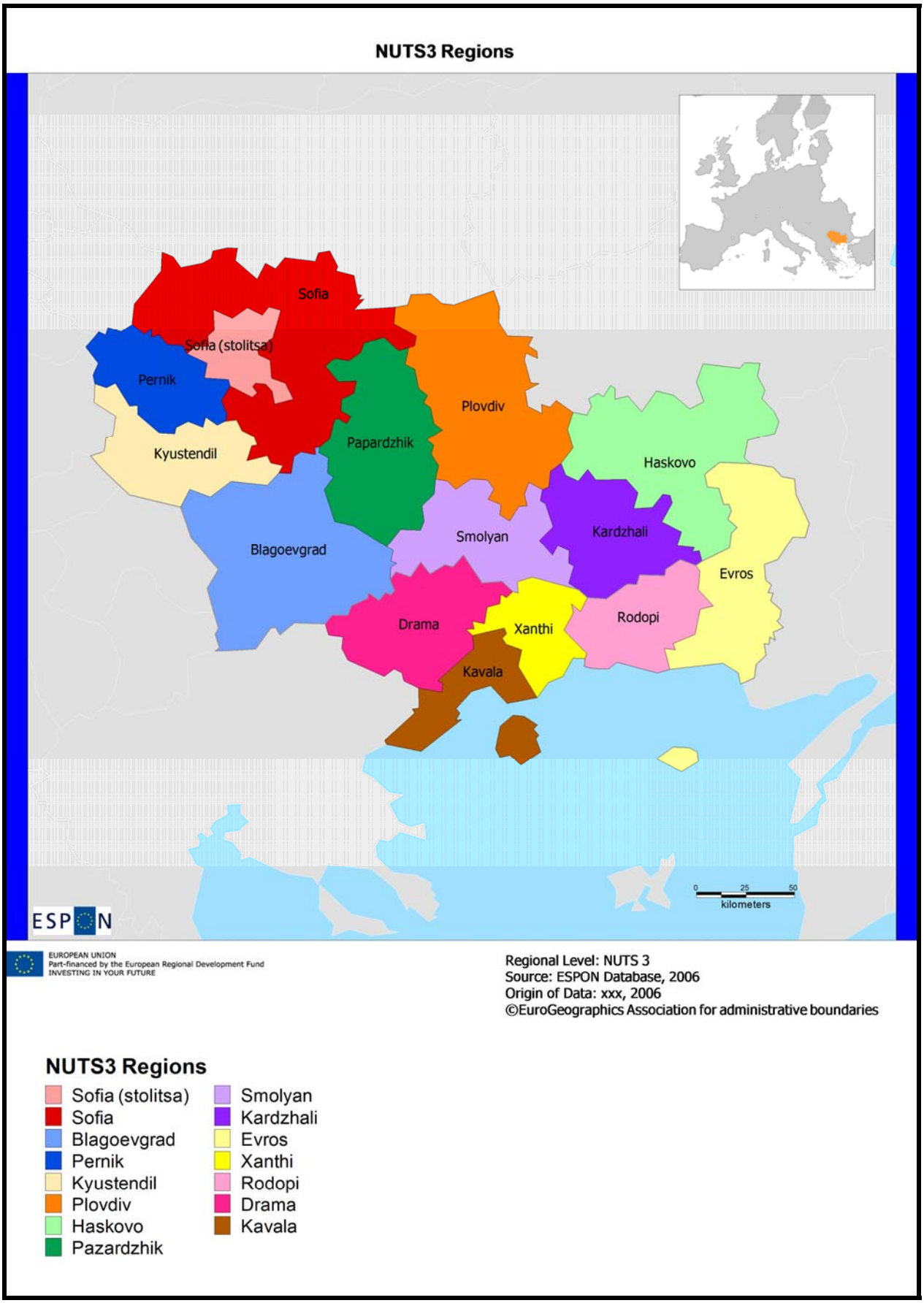

Figure 2. Map of NUTS3 level units of the Greece – Bulgaria CBA.

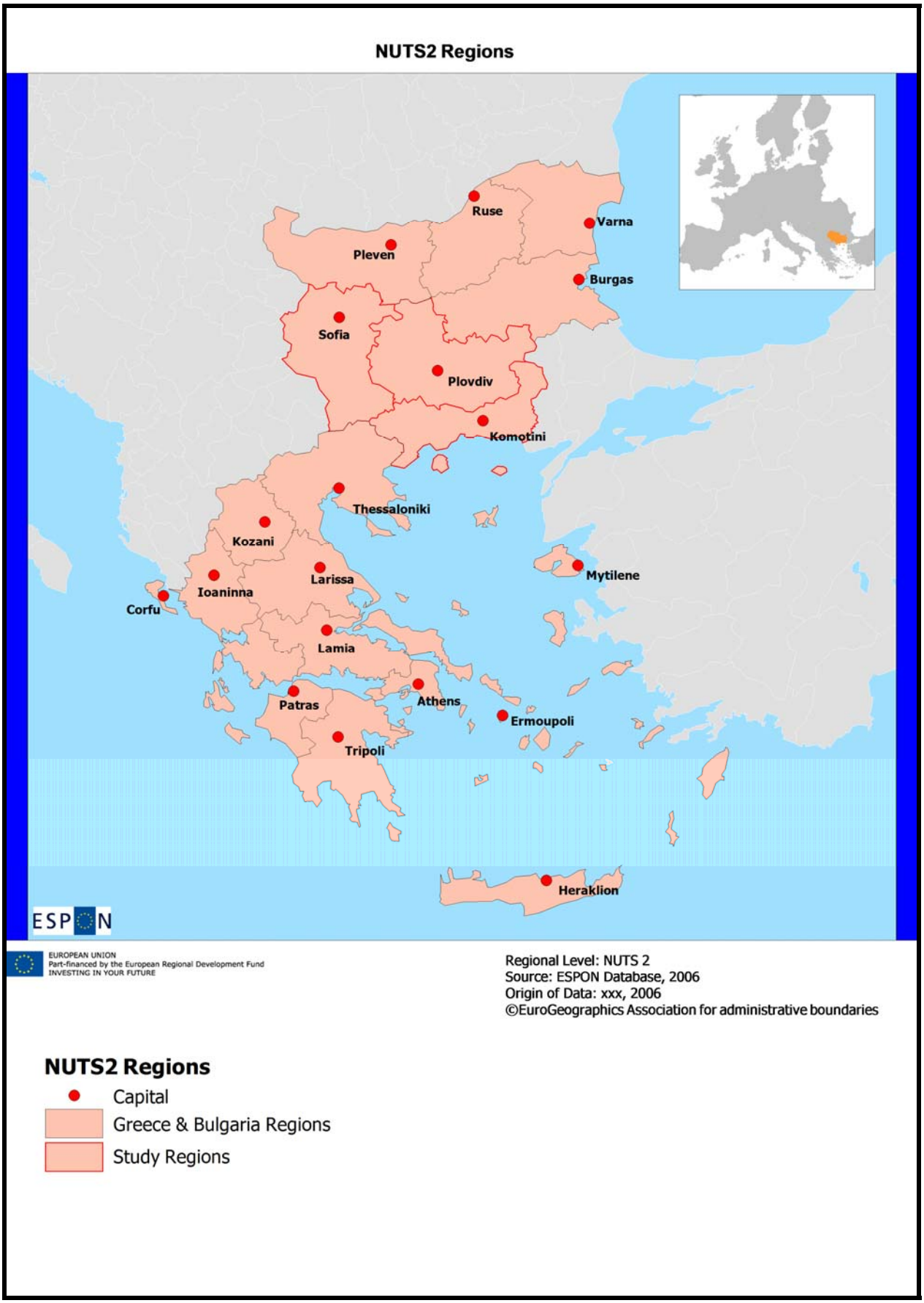

Figure 3. Map of Greece and Bulgaria presenting the Greece – Bulgaria Cross-Border Area and the NUTS1, 2 administrative centres.

Komotini, the administrative centre of Anatoliki Makedonia, Thraki is located approximately 746 km to the north-east of Athens, the capital of Greece. On the other hand, the capital of Bulgaria, Sofia, is part of the Greece – Bulgaria CBA, located at its north-western part. Sofia is further the administrative centre for Yugozapaden region, while Plovdiv, the administrative centre for the Yuzhen tsentralen region, is located 131 km to the south-east of Sofia (Figure 3).

1.3. Total Area of the Greece – Bulgaria CBA

The Greece – Bulgaria Cross-Border Area occupies a total area of 56,828.40 sq km (Table 2). Anatoliki Makedonia, Thraki covers an area of 14,157.0 sq km (i.e., 43.07%) of Greece, while Yugozapaden and Yuzhen tsentralen regions occupy in total 42,671.5 sq km (i.e., 51.20%) of Bulgaria.

At NUTS2 level, Yuzhen tsentralen represents 39.36% of the CBA's total area, Yugozapaden the 35.73% while Anatoliki Makedonia, Thraki only 24.91%. Sofia oblast (BG412) and Blagoevgrad (BG413) are the largest NUTS3 level units of the CBA, occupying 7,062.3 sq km and 6,449.5 sq km, respectively. Sofia stolitsa (BG411) and Xanthi (GR112) are the smallest NUTS3 level units of the CBA, covering 1,348.9 sq km and 1,793.0 sq km, respectively (Table 2).

Table 2. Total Area of NUTS1, 2 and 3 level units of the Greece – Bulgaria CBA.

	CODE	NUTS-ID	Total Area (sq.km)	(%) of CBA
Bulgaria	BG	NUTS1	111,001.9	
Yugozapaden	BG41	NUTS2	20,306.4	35.73
Sofia (stolitsa)	BG411	NUTS3	1,348.9	
Sofia	BG412	NUTS3	7,062.3	
Blagoevgrad	BG413	NUTS3	6,449.5	
Pernik	BG414	NUTS3	2,394.2	
Kyustendil	BG415	NUTS3	3,051.5	
Yuzhen tsentralen	BG42	NUTS2	22,365.1	39.36
Plovdiv	BG421	NUTS3	5,972.9	
Haskovo	BG422	NUTS3	5,533.3	
Pazardzhik	BG423	NUTS3	4,456.9	
Smolyan	BG424	NUTS3	3,192.8	
Kardzhali	BG425	NUTS3	3,209.1	
Greece	GR	NUTS1	131,957.0	
Anatoliki Makedonia, Thraki	GR11	NUTS2	14,157.0	24.91
Evros	GR111	NUTS3	4,242.0	
Xanthi	GR112	NUTS3	1,793.0	
Rodopi	GR113	NUTS3	2,543.0	
Drama	GR114	NUTS3	3,468.0	
Kavala	GR115	NUTS3	2,111.0	
Total CBA Area			56,828.4	

Chapter 2 – Demographic Analysis

2.1. Aims, Indicators and Methods

Demographic Analysis of the Greece – Bulgaria CBA aims to identify the behaviour of the cross-border region in terms of population spatial distribution and temporal dynamics. The main objective is to understand the influence of the border on the settlement and population patterns of the CBA. The key questions to be answered are: Is the Greece – Bulgaria border attracting or repulsing local population? Is the population of the Greece – Bulgaria border region growing faster or slower than non-border regions? Is the population of the Greece – Bulgaria border region ageing more or less rapidly than in non-border regions?

To answer to the above questions, a set of indicators has been identified, as the CBA's total population; the population growth; the population density; the total and partial dependency rates; the ageing index; and the fertility rates.

Although most of the demographic indicators are straightforward, some of them could be subjected to more detailed analyses. This applies specifically to population growth and demographic potential.

Regarding population growth, a simply comparison to other geographical units appears insufficient, since this indicator is very dependent on the population density of the region under analysis. This means that, in order to actually be able to understand whether the population growth is related to the border effect, a function that considers population density as well as the distance to the border should be applied, preferably at NUTS4 unit level.

$$Growth\ Rate = A + a_{db}\, db + a_{d}\, d + \varepsilon \qquad (1)$$

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

The demographic potential, on the other hand, can be performed in order to detect the effect of borders on the patterns of settlement. For this it is necessary to perform a more detailed analysis at the NUTS4 unit level, in which the demographic potential of the NUTS4 neighbouring the border is calculated and compared with the average potential of the corresponding NUTS3 and NUTS2 unit

levels. This is expected to show whether the border attracts or repulses human settlements. The demographic potential of a given point i relative to j can be obtained through the following formula:

$$V_j = \sum_j \frac{P_j}{d_{i,j}} \quad (2)$$

where V_j is the demographic potential in region j, P_j is the population in region j, and $d_{i,j}$ is the distance between regions j and i. To analyse this indicator on a regional level, the population and distances between the capital or centroid of the different NUTS4 in a cross-border region as well as neighbouring NUTS3 has to be made available. For both of these indicators, the indicator for distance should ideally be the actual travel time by road. This might not be justified by the scope of this project, and therefore a simplified version can be done based on the air distance.

More specifically, the parameters and indicators analysed for the Greece – Bulgaria Cross-Border Region, are shown in Table 3.

Table 3. Demographic Parameters studied for Greece – Bulgaria CBA.

Parameter – Indicator	Period Covered	Data Source	NUTS Unit Level
Total Population	1999 - 2009	ESPON 2013 Database	NUTS1, 2, 3, EU27
Total Population by Sex	1999 – 2008	ESPON 2013 Database	NUTS1, 2, 3, EU27
Total Population by Age	1999 – 2009	ESPON 2013 Database	NUTS1, 2, 3, EU27
Population Density	1999 – 2009	ESPON 2013 Database	NUTS1, 2, 3, EU27
Population Growth	2004, 2009	ESPON 2013 Database	NUTS1, 2, 3, EU27
Crude Rate of Net Migration	2000 – 2008	Eurostat	NUTS1, 3, EU27
Fertility Rates	1999 – 2009	Eurostat	NUTS1, 2, EU27
Total dependency Rates	1999 – 2009	Eurostat	NUTS1, 3, EU27
Ageing Index	1999 – 2009	Eurostat	NUTS1, 2, 3, EU27

2.2. Total Population

The total population in 2009 of the Greece – Bulgaria CBA is 4,247,739 inhabitants. This population represents approximately 0.85% of the total EU27 population (499,705,496 inhabitants in 2009). Further, CBA's population represents 55.84% of the total population of Bulgaria (7,606,551 inhabitants) and 32.72% of the total population of Greece (11,260,402 inhabitants).

Yugozapaden has a total population of 2,115,042 inhabitants (49.79% of CBA population), Yuzhen tsentralen has a population of 1,538,142 inhabitants (36.21% of CBA population) and Anatoliki Makedonia, Thraki a total population of 606,622 inhabitants (14.28% of CBA population).

Sofia (stolitsa) (BG411) and Plovdiv (BG421) are the NUTS3 level units with the higher contribution in the total population of the CBA. Drama (GR114) and Xanthi (GR112) are the NUTS3 level units with the lowest total population in the Greece – Bulgaria CBA. Table 4 presents the total population of the CBA in NUTS1, 2 and 3 unit levels for the year 2009. Figures 4 and 5 presents the percentage of each NUTS3 level unit contribution in the Total Population of the Greece – Bulgaria CBA (year 2009) and the map of total population distribution in the CBA.

Table 4. Total Population in 2009 for the Greece – Bulgaria CBA.

	CODE	NUTS-ID	2009
Bulgaria	BG	NUTS1	7,606,551
Yugozapaden	BG41	NUTS2	2,115,042
Sofia (stolitsa)	BG411	NUTS3	1,249,798
Sofia	BG412	NUTS3	253,010
Blagoevgrad	BG413	NUTS3	327,885
Pernik	BG414	NUTS3	136,249
Kyustendil	BG415	NUTS3	145,577
Yuzhen tsentralen	BG42	NUTS2	1,538,142
Plovdiv	BG421	NUTS3	701,684
Haskovo	BG422	NUTS3	256,408
Pazardzhik	BG423	NUTS3	290,614
Smolyan	BG424	NUTS3	124,795
Kardzhali	BG425	NUTS3	154,719
Greece	GR	NUTS1	11,260,402
Anatoliki Makedonia, Thraki	GR11	NUTS2	606,622
Evros	GR111	NUTS3	149,000
Xanthi	GR112	NUTS3	107,000
Rodopi	GR113	NUTS3	111,000
Drama	GR114	NUTS3	100,000
Kavala	GR115	NUTS3	140,000
Total CBA Population			4,247,739

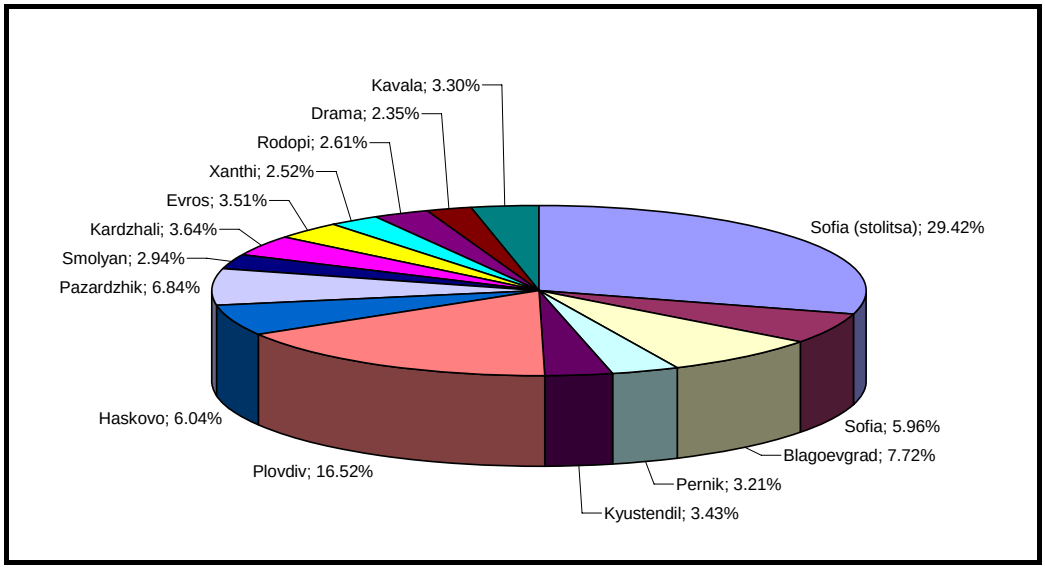

Figure 4. Percent of each NUTS3 level unit contribution in the Total Population of the Greece – Bulgaria CBA.

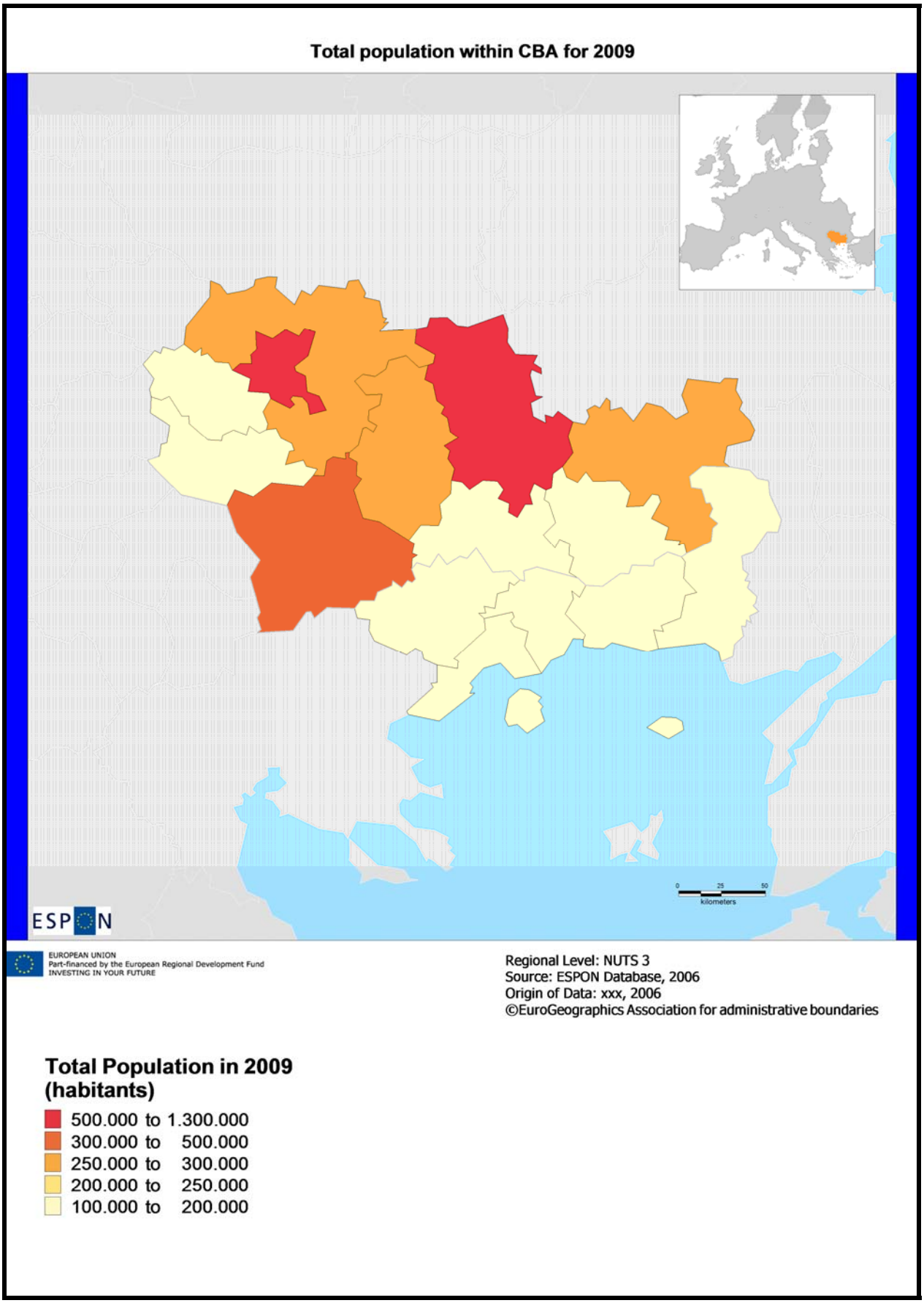

Figure 5. Total population of NUTS3 unit levels of Greece – Bulgaria CBA.

2.3. Total Population by Sex

Based on the 2008 demographic data, the total population of the Greece – Bulgaria CBA is approximately comprised by 2,067,000 males (i.e., 48.48% of total population) and 2,197,000 females (i.e., 51.52% of total population). This is in analogy to the NUTS1 unit level percentages (48.41% males and 51.59% females in Bulgaria and 49.52% males and 50.48% females in Greece). Similarly, in EU27 the males-to-females proportion is 48.80% and 51.20%, respectively.

Anatoliki Makedonia, Thraki is the most balanced male-to-female NUTS2 unit level region (49.92% males and 50.08% females), followed by Yuzhen tsentralen (48.51% males and 51.49% females). Yugozapaden has the highest disproportional population by sex (48.04% males and 51.96% females).

In terms of the NUTS3 level units participating in the Greece – Bulgaria CBA, Evros (GR111) shows the highest males-to-females analogy (52.35% males and 47.65% females), Sofia (stolitsa) presents the lowest (47.51% males and 52.49% females), while Xanthi (GR112) appears absolutely balanced (50.00% males and females, respectively). Figure 6 presents the males to females' percentages in the various NUTS3 level units of the Greece – Bulgaria CBA.

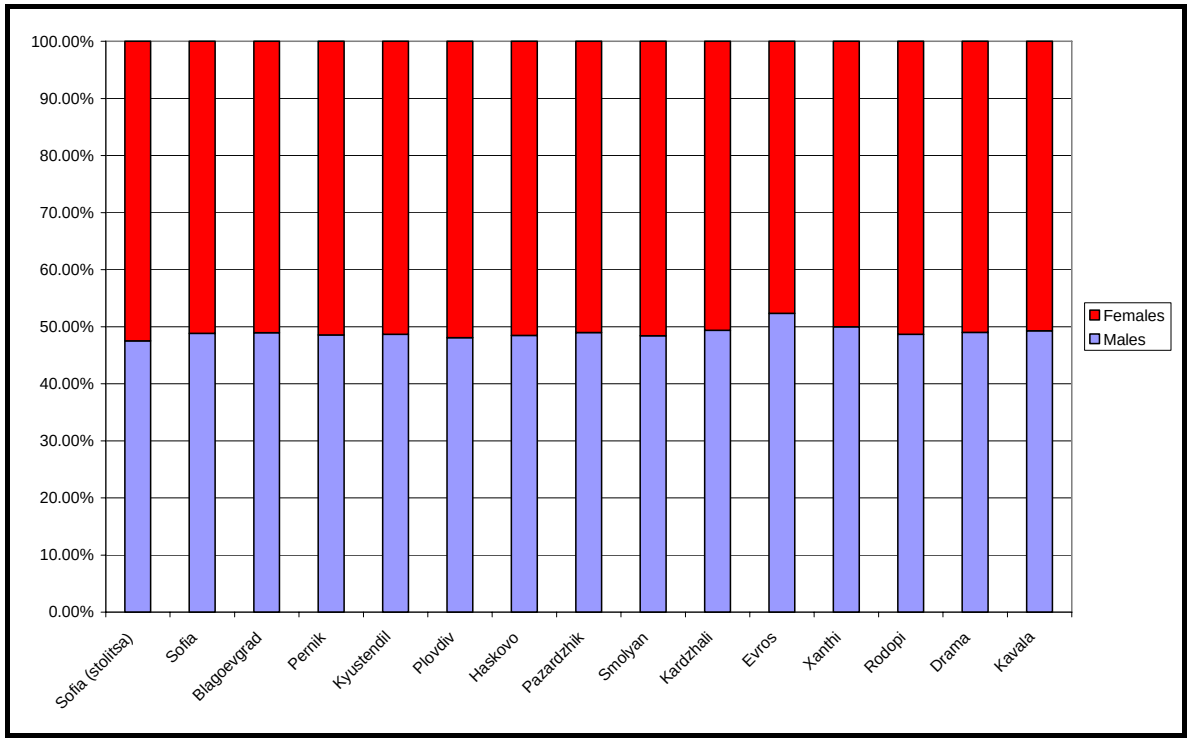

Figure 6. Percent of males and females in each NUTS3 level unit of the Greece – Bulgaria CBA (year 2009).

2.4. Total Population by Age

Three age classes were considered in the analysis: a) total population aged between 0-14 years old; b) total population aged between 15-64 years old; and c) total population aged over 65 years old. The average proportions of total population of the Greece – Bulgaria CBA in the three above defined age classes are 13.52% (between 0-14 years old), 68.03% (between 15-64 years old) and 18.45% (over 65 years old). CBA's population distribution in these three age classes appears in analogy with the National Bulgarian proportions (13.40% between 0-14 years old; 69.10% between 15-64 years old; and 17.50% over 65 years old). Greece's National Statistics show a higher proportion than the CBA in the over 65 years old population (18.70%), lower proportion in the 15-65 years old population (67.00%) and higher proportion in the 0-14 years old population (14.30%). The corresponding EU27 population distributions are 15.60% for the age group 0-14 years old, 67.10% for the age group 15-64 years old and 17.30% for the over 65 years old age group.

In terms of the NUTS3 level units of the Greece – Bulgaria CBA, the most over-aged population is found in Drama (GR114), Evros (GR111), Kavala (GR115),Pernik (BG414), and Kyustendil (BG415) having 22.97%, 21.87%, 21.62%, 21.50% and 21.39%, respectively, of their total population being over 65 years old. The highest proportions in young-aged population (age class between 0 and 14 years old) are found in Xanthi (GR112), Kardzhali (BG425) and Pazardzhik (BG423) with 18.39%, 14.58% and 14.42% of their total population, respectively. Figure 7 illustrates the relative proportions in these three age classes for each NUTS3 level unit of the Greece – Bulgaria CBA for year 2009.

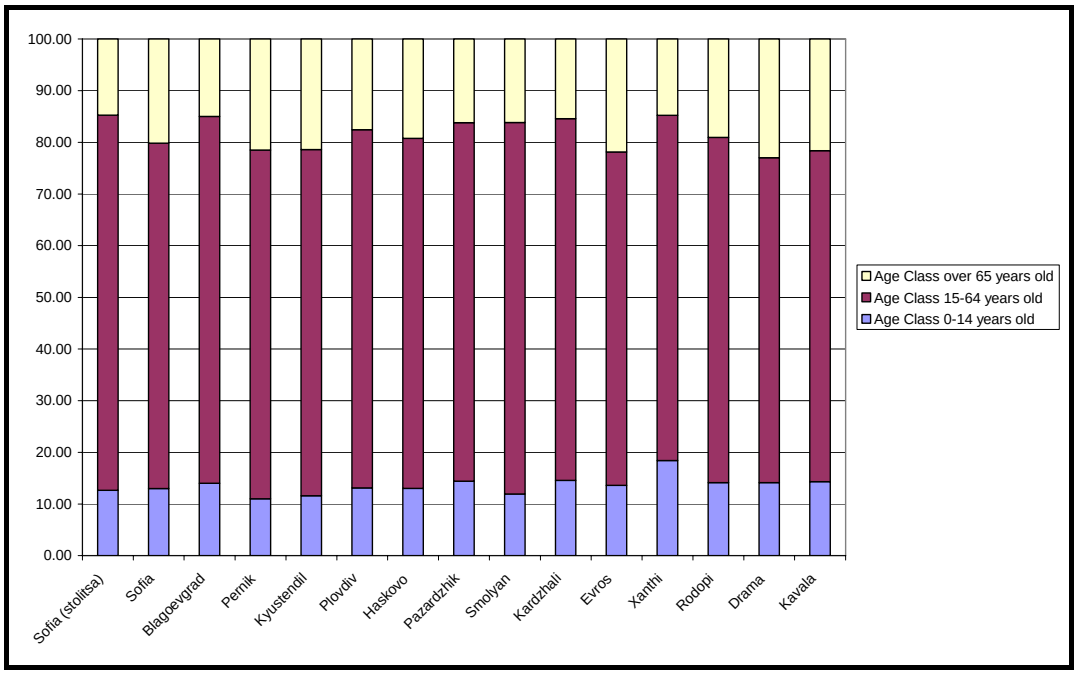

Figure 7. Relative proportions of the three age classes for each NUTS3 level unit of the Greece – Bulgaria CBA (year 2009).

2.5. Population Growth

Population growth is the change in CBA's population over time. Population growth (ΔP) is determined by four factors, births (B), deaths (D), immigrants (I), and emigrants (E). Population growth may be determined using a formula expressed as:

$$\Delta P \equiv B - D + I - E \quad (3)$$

Therefore, population growth in a certain period can be calculated in two parts, **natural growth of population** (B – D) and **mechanical growth of population** (I – E).

For the Greece – Bulgaria CBA demographic analysis two five-year periods were defined: a) 1999 – 2004, and b) 2005 – 2009. Population growth was defined as:

$$Population\,Growth = \frac{Population\ at\ year\,T - Population\,at\ year\,(T-5)}{Population\,at\ year\,(T-5)} \quad (4)$$

A positive population growth rate indicates that the population is increasing, while a negative growth ratio indicates the population is decreasing.

The Greece – Bulgaria CBA shows negative population growths in both periods, i.e., -3.25% in the period 1999 – 2004 and -1.05% in the period 2005 – 2009. Overall, the Greece – Bulgaria CBA reduced its total population by 189.261 inhabitants (reduction of 144,304 inhabitants in the period 1999-2004 and reduction of 44,957 inhabitants in the period 2005-2009).

This negative trend in CBA's population is mostly affected by the significant population reduction in Yuzhen tsentralen (-6.5% in period 1999 – 2004 and 2.67% in period 2005 – 2009). Yugozapaden shows negative growth in the first period (-1.48%) and slightly positive in the second (0.24%). Anatoliki Makedonia, Thraki shows slightly positive population growth in both examined periods (0.47% and 0.17%, respectively).

The NUTS3 level unit with the highest negative population growth rate is Kardzhali (BG425) with -24.59% in 1999 – 2004 and -3.23% in 2005 – 2009, followed by Smolyan (BG424) with -13.06% and -6.18% in the two respective periods. Strongly positive population growths are found in Xanthi (GR112) with 3.66% and 2.20%, followed by Sofia (stolitsa) (BG411) with 2.19% and 2.35%, respectively, for the two examined periods.

Table 5. Population growth of each NUTS3 level unit of the Greece – Bulgaria CBA, for the periods 1999 – 2004 and 2005 – 2009.

	CODE	NUTS-ID	PERIOD 1999 - 2004	PERIOD 2005 - 2009
Bulgaria	BG	NUTS1	-5.21%	-2.50%
Yugozapaden	BG41	NUTS2	-1.48%	0.24%
Sofia (stolitsa)	BG411	NUTS3	2.19%	2.35%
Sofia	BG412	NUTS3	-2.95%	-3.44%
Blagoevgrad	BG413	NUTS3	-4.04%	-2.10%
Pernik	BG414	NUTS3	-8.81%	-4.22%
Kyustendil	BG415	NUTS3	-9.67%	-5.76%
Yuzhen tsentralen	BG42	NUTS2	-6.50%	-2.67%
Plovdiv	BG421	NUTS3	-2.09%	-1.15%
Haskovo	BG422	NUTS3	-6.18%	-4.44%
Pazardzhik	BG423	NUTS3	-5.93%	-3.16%
Smolyan	BG424	NUTS3	-13.06%	-6.18%
Kardzhali	BG425	NUTS3	-24.59%	-3.23%
Greece	GR	NUTS1	1.65%	1.99%
Anatoliki Makedonia, Thraki	GR11	NUTS2	0.47%	0.17%
Evros	GR111	NUTS3	0.61%	0.07%
Xanthi	GR112	NUTS3	3.66%	2.20%
Rodopi	GR113	NUTS3	1.09%	-0.18%
Drama	GR114	NUTS3	0.20%	-1.19%
Kavala	GR115	NUTS3	-0.21%	-0.50%

At NUTS1 unit level, Bulgarian total population shows a significant reduction of -5.21% in the period 1999 – 2004 and -2.50% in the period 2005 – 2009. On the contrary, Greece show population increase of 1.65% and 1.99%, respectively, in the two examined periods. EU27 space shows total population increases of 1.49% for the period 1999 – 2004 and 2.23% for the period 2005 – 2009.

The annual population growth rates of each NUTS3 level units of the Greece – Bulgaria CBA for the period 1999 – 2009 are shown in Table 6. The corresponding rate of EU27 for the same period is also shown. It occurs that only Xanthi (GR112) and Sofia (stolitsa) (BG411) have annual population growth rates higher than the mean annual EU27 population growth rate (+0.34%).

Based on the annual population growth rate in NUTS3 level units of the Greece – Bulgaria CBA, and comparing these rates to CBA's average, a categorization scheme is devised (Figure 8), comprised of:

- regions with strongly positive growth rate (Xanthi, GR112 and Sofia stolitsa, BG411);
- regions with nearly zero change (Evros, GR111 and Rodopi, GR113);

- regions with negative growth rate slightly lower than CBA average (Kavala, GR115 and Drama, GR114);
- regions with almost equal to CBA growth rate (Plovdiv, BG421);
- regions with negative growth rate slightly higher than CBA average (Sofia, BG412, Blagoevgrad, BG413, Haskovo, BG422, and Pazardzhik, BG423); and
- regions with negative growth rate higher than CBA average (Smolyan, BG424, Kardzhali, BG425, Pernik, BG414 and Kyustendil, BG415).

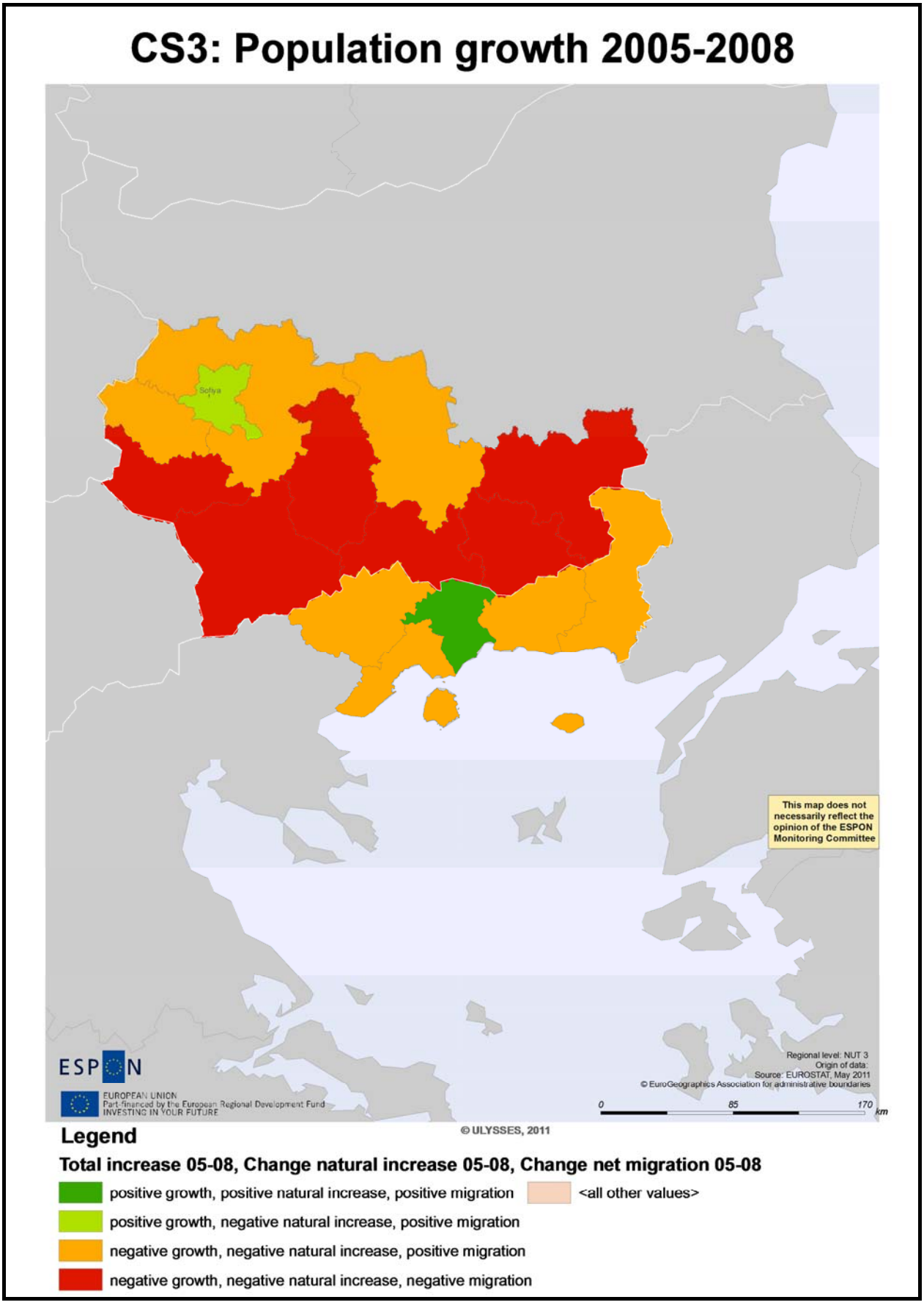

Figure 8. Category map of annual population growth of NUTS3 level units in relation to the average population growth rate of the Greece – Bulgaria CBA.

Table 6. Population Growth of BUTS3 unit levels in the Greece – Bulgaria CBA.

Region name	Region code (NUTS 3)	Total population 1999	% of CBA	Total population 2009	% of CBA	Total population change 1999 to 2009	Total population change 1999 to 2009 (EU27)	Annual CBA population growth 1999-2009	Annual population growth 1999-2009 (EU27)
Sofia (stolitsa)	BG411	1,195,000	26.93%	1,249,798	29.42%	54,798		0.42%	
Sofia	BG412	270,000	6.09%	253,010	5.96%	-16,990		-0.57%	
Blagoevgrad	BG413	349,000	7.87%	327,885	7.72%	-21,115		-0.55%	
Pernik	BG414	156,000	3.52%	136,249	3.21%	-19,751		-1.15%	
Kyustendil	BG415	171,000	3.85%	145,577	3.43%	-25,423		-1.35%	
Plovdiv	BG421	725,000	16.34%	701,684	16.52%	-23,316		-0.29%	
Haskovo	BG422	286,000	6.45%	256,408	6.04%	-29,592		-0.94%	
Pazardzhik	BG423	319,000	7.19%	290,614	6.84%	-28,386	18,087,739	-0.81%	0.34%
Smolyan	BG424	153,000	3.45%	124,795	2.94%	-28,205		-1.68%	
Kardzhali	BG425	212,000	4.78%	154,719	3.64%	-57,281		-2.46%	
Evros	GR111	148,000	3.34%	149,000	3.51%	1,000		0.06%	
Xanthi	GR112	101,000	2.28%	107,000	2.52%	6,000		0.54%	
Rodopi	GR113	110,000	2.48%	111,000	2.61%	1,000		0.08%	
Drama	GR114	101,000	2.28%	100,000	2.35%	-1,000		-0.09%	
Kavala	GR115	141,000	3.18%	140,000	3.30%	-1,000		-0.06%	
Total CBA		4,437,000		4,247,739		-189,261		-0.59%	

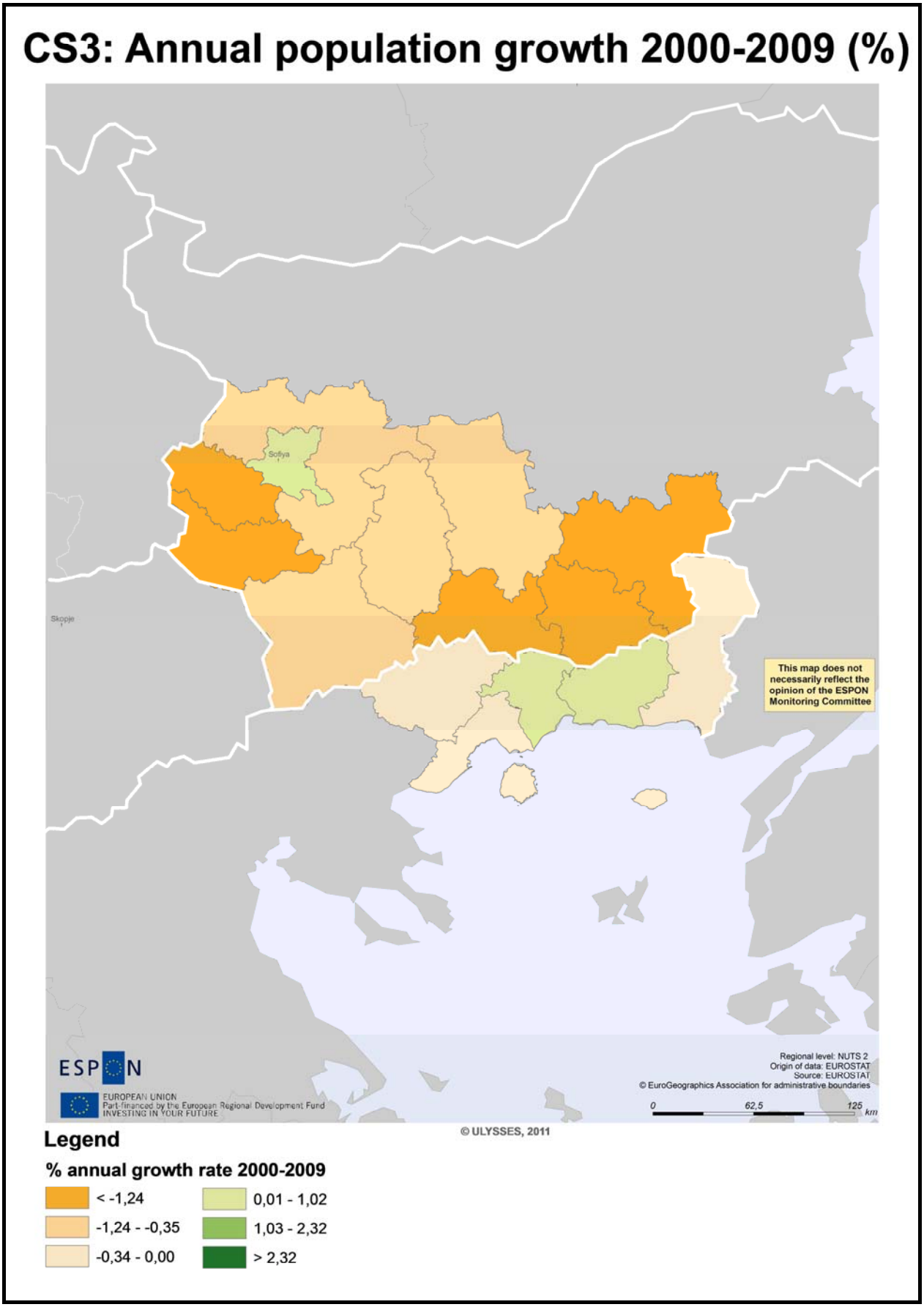

Figure 9. Map of annual population growth of NUTS3 level units (period 2000 – 2009) of the Greece – Bulgaria CBA.

Figure 9 presents the total population change of the NUTS3 level units of the Greece – Bulgaria CBA. To understand better the mechanisms of population change in the Greece – Bulgaria CBA, for the years 2000 – 2008, decomposition has taken place following eq. 3, into the natural increase (births – deaths) and the net migration (immigrants – emigrants) (Table 7). Results show that net migration is responsible for the population increase in Sofia (stolitsa) (BG411), while natural increase for Xanthi (GR113). Population reduction due to negative natural increase is shown in Plodviv (BG421), Drama (GR114) and Kavala (GR115). Population decrease due to both natural increase and net migration is taken place in all other NUTS3 unit levels of the Greece – Bulgaria CBA.

Table 7. Decomposed population change of NUTS3 level units of Greece – Bulgaria CBA for the period 2000 – 2008.

Region name	Region code (NUTS)	Years 2000 to 2008		Period 2000-2008	Period 2000-2008
		Natural Increase	Net Migration	Categorization (+ +, + -, - +, - -)	Impact on the total population change
Bulgaria	BG	-368,731	-215,594	**- -**	Negative growth
Yogozapaden	BG41	-80,848	+53,190	**- +**	Negative growth
Sofia (stolitsa)	BG411	-31,109	+66,637	**- +**	Positive growth
Sofia	BG412	-19,206	+11,275	**- +**	Negative growth
Blagoevgrad	BG413	-4,681	-11,674	**- -**	Negative growth
Pernik	BG414	-12,630	-3,242	**- -**	Negative growth
Kyustendil	BG415	-13,222	-9,806	**- -**	Negative growth
Yuzhen tsentralen	BG42	-60,149	-85,253	**- -**	Negative growth
Plovdiv	BG421	-27,892	+2,502	**- +**	Negative growth
Haskovo	BG422	-16,841	-15,922	**- -**	Negative growth
Pazardzhik	BG423	-9,995	-12,696	**- -**	Negative growth
Smolyan	BG424	-4,699	-14,705	**- -**	Negative growth
Kardzhali	BG425	-722	-44,432	**- -**	Negative growth
Greece	GR	+18,403	+338,242	**+ +**	Positive growth
Anatoliki Makedonia, Thraki	GR11	-3,594	+5,000		Positive growth
Evros	GR111	-2,549	+2,100	**- +**	Negative growth
Xanthi	GR112	+4,226	+600	**- +**	Positive growth
Rodopi	GR113	-648	+1,100	**- +**	Positive growth
Drama	GR114	-2,291	+400	**- +**	Negative growth
Kavala	GR115	-2,262	+800	**- +**	Negative growth
Total CBA		-144,521	-27,063	**- -**	Negative growth

2.6. Population Change and Projections

Following the temporal variability of total population in the Greece – Bulgaria CBA, a gradual decrease is depicted, expressed by a linear regression model (Figure 10).

The equation:

$$\text{CBA Population} = -16{,}509\,(\text{Year} - 1999) + 4 \times 10^6 \qquad (5)$$

allows the projection of CBA's total population for the year 2020, estimated at 3,653,311 inhabitants. The corresponding linear regression equations and the produced projections for year 2020 are provided in Table 8. It occurs that by year 2020 only Evros (GR 111), Xanthi (GR113) and Sofia (stolitsa) (BG411) are expected to increase their total population.

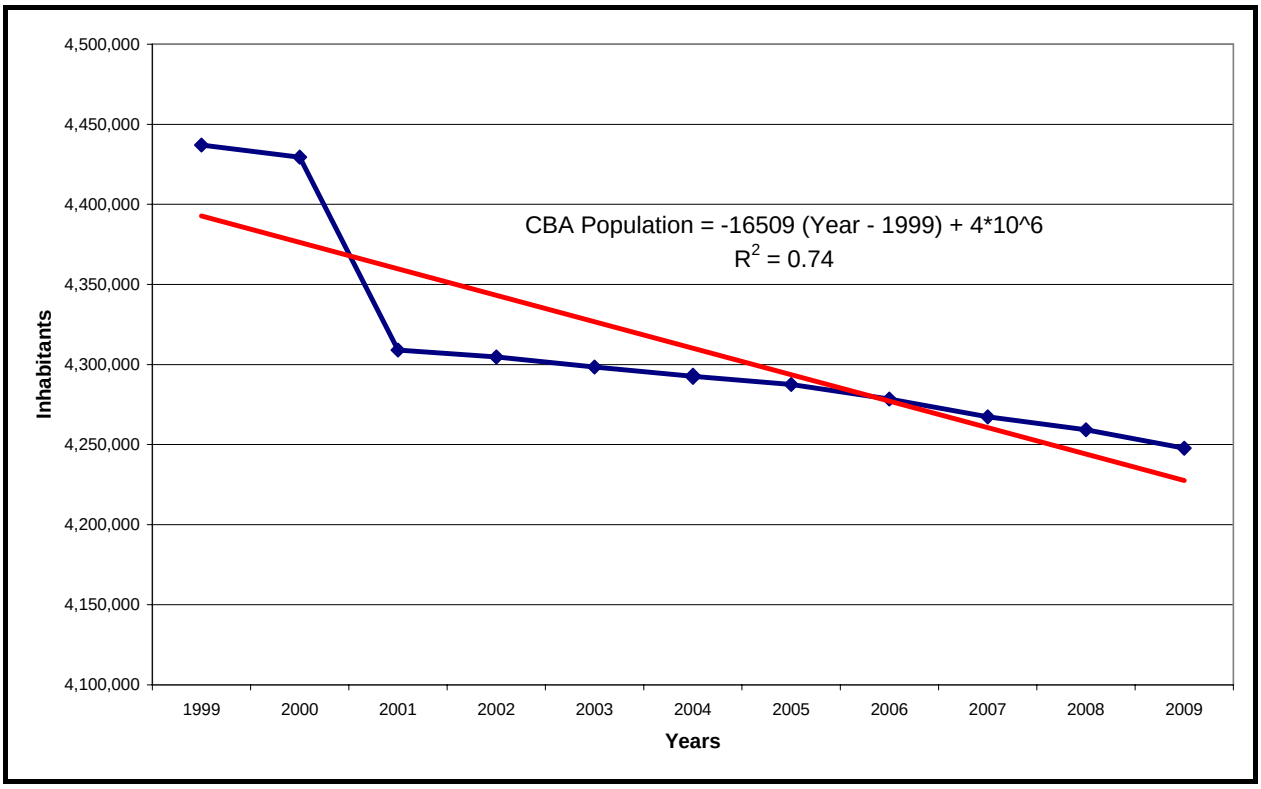

Figure 10. Total population change of Greece – Bulgaria CBA for the period 1999 – 2009 and linear regression for population projection.

Table 8. Linear regression models for NUTS3 level units of the Greece – Bulgaria CBA and year 2020 population projections.

Region name	Linear Regression Model	R^2	Year 2020 projection
Sofia (stolitsa)	6,588.1 t + 1,180,000	0.73	1,318,350
Sofia	-1,624 t + 271,640	0.68	237,536
Blagoevgrad	-2,017 t + 347,856	0.95	305,499
Pernik	- 1,907 t + 155,606	0.96	115,559
Kyustendil	- 2,513 t + 171,463	0.96	118,690
Plovdiv	- 2,415.5 t + 726,260	0.87	675,545
Haskovo	- 3,126 t + 289,152	0.92	223,506
Pazardzhik	- 2,776 t + 319,048	0.98	260,098
Smolyan	- 2,462 t + 149,752	0.92	98,050
Kardzhali	- 4,566 t + 195,092	0.60	99,206
Evros	52.727 t + 148,584	0.23	149,691
Xanthi	530 t + 101,302	0.96	112,432
Rodopi	47.273 t + 110,735	0.19	111,727
Drama	-171.82 t + 102,140	0.65	98,531
Kavala	-148.18 t + 141,571	0.88	138,459

2.7. Total Fertility Rates

Total Fertility Rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates.

For the Greece – Bulgaria CBA, fertility rates are reported only at NUTS2 level units. The mean fertility rate for the CBA is 1.48, equal to the corresponding rate of Bulgaria and slightly lower than the fertility rate of Greece (1.51). This rate appears significantly lower than the mean EU27 fertility rate of 1.60.

In terms of NUTS2 level units, Yugozapaden exhibits the lower fertility rate in the CBA (1.37), followed by Yuzhen tsentralen (1.45). Anatoliki Makedonia, Thraki shows a fertility rate for year 2008 of 1.61, higher than the corresponding NUTS1 value. The temporal evolution of fertility rates at NUTS2 level for the period 1999 – 2008 shows a gradual increase of these rates in all regions of the CBA (Figure 11). The highest fertility rate increase in this period was computed for Yugozapaden (30.48%), then by Yuzhen tsentralen (19.83%) and lastly by Anatoliki Makedonia, Thraki (12.59%). Figure 12 illustrates the spatial distribution of total fertility rates at NUTS3 level of the Greece – Bulgaria CBA.

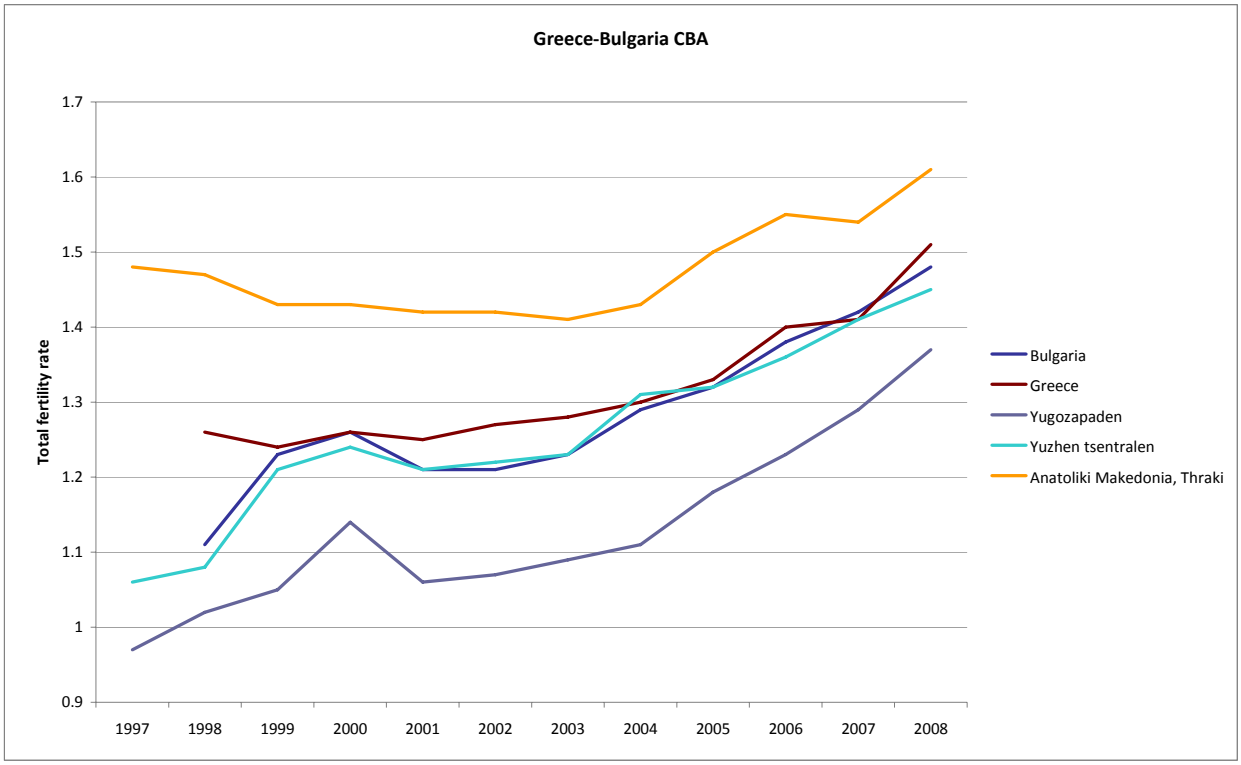

Figure 11. Evolution of fertility rates at NUTS0 and 2 level units of the Greece – Bulgaria CBA.

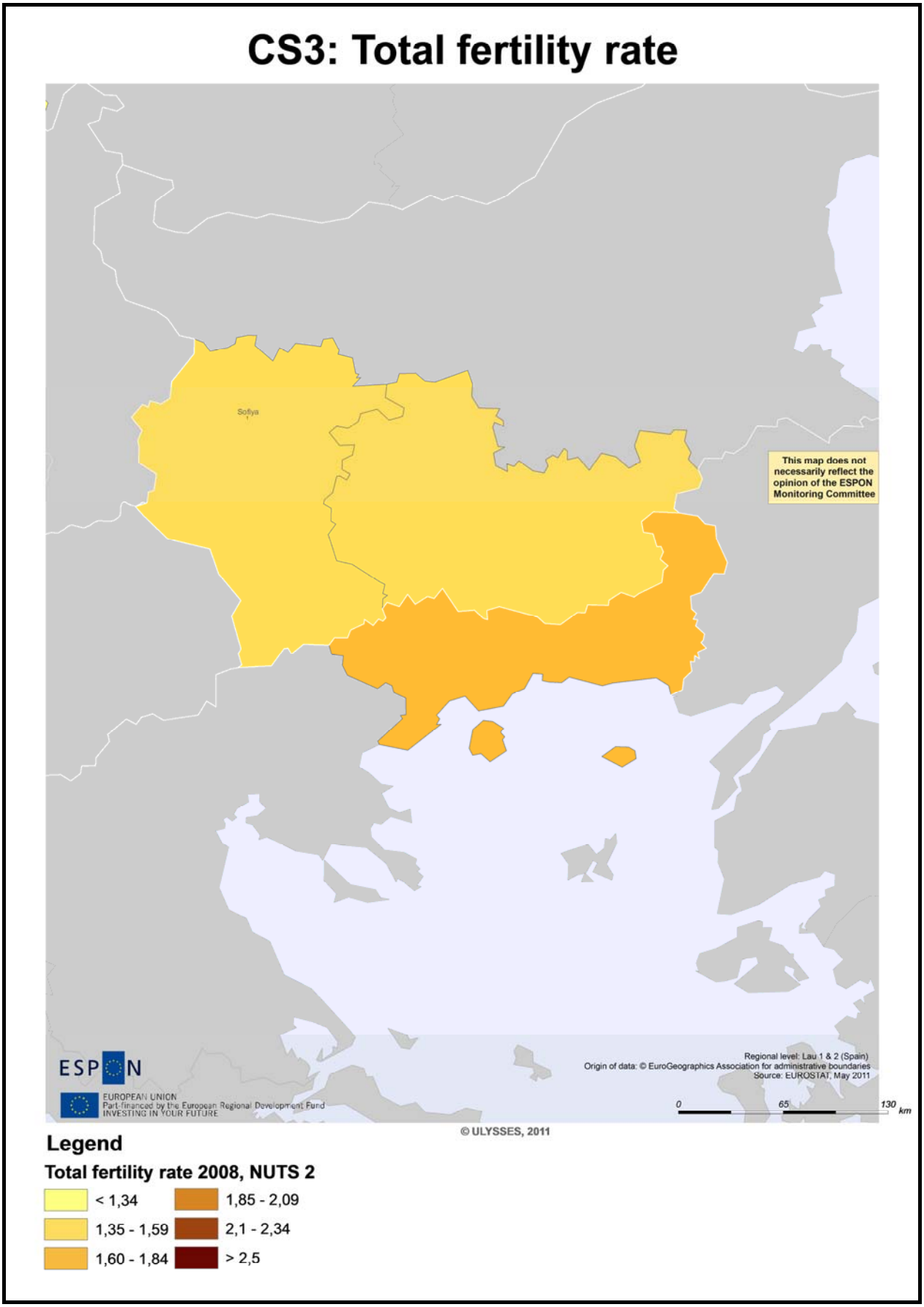

Figure 12. Map of total fertility rates of the NUTS3 level units (year 2008) of the Greece – Bulgaria CBA.

2.8. Population Density

Population density is a key geographic parameter expressing the total population per unit area, usually per sq km.

For the Greece – Bulgaria CBA, population density is reported at NUTS1, 2 and 3 level units. The mean population density of the CBA for the year 2008 is 111.4 inhabitants per sq km, significantly higher than the mean value of Bulgaria (68.7 inhabitants per sq km) and Greece (85.9 inhabitants per sq km). CBA's population density appears of the same order as the mean EU27 corresponding value (116.0 inhabitants per sq km).

In NUTS3 level units, population density appears mostly affected by the existence of urban centres in some regions in Bulgaria, as Sofia (stolitsa) (BG411) with population density of 922.2 inhabitants per sq km and Plovdiv (BG421) with population density of 118.0 inhabitants per sq km. These centres affect the population density of Yugozapaden (104.1 inhabitants per sq km) and Yuzhen tsentralen (68.9 inhabitants per sq km). The rest of Bulgarian NUTS3 level units show significantly lower population densities (mean: 49.4 inhabitants per sq km).

In Anatoliki Makedonia, Thraki urban centres are almost equal and of medium size, exhibiting an average population density of 43.1 inhabitants per sq km, with higher population density in Kavala (GR115, 66.8 inhabitants per sq km) and the lower in Drama (GR114, 28.9 inhabitants per sq km), which is the lowest population density value in the whole CBA.

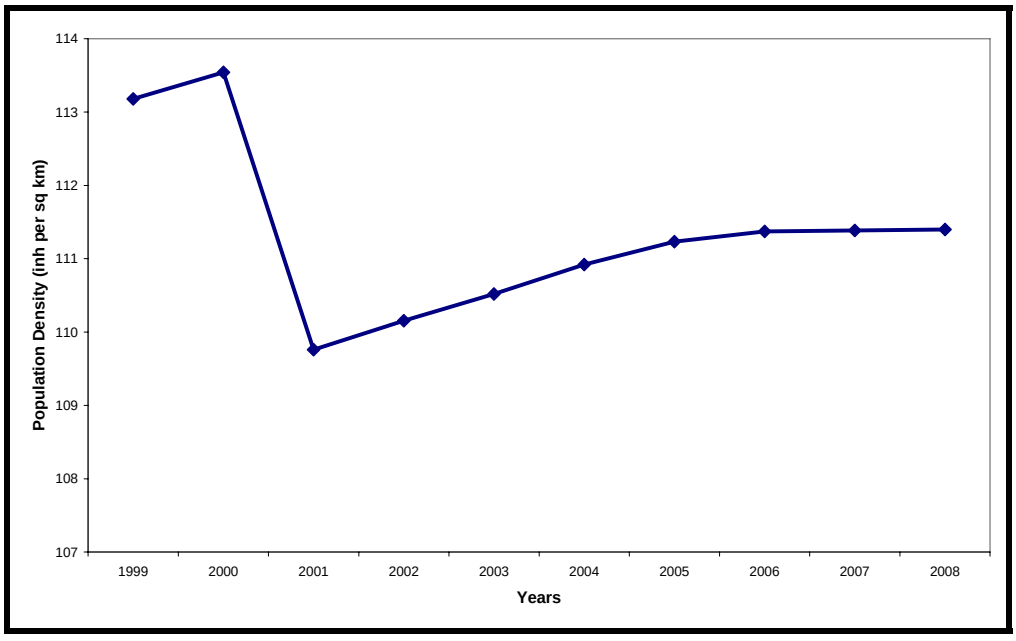

Figure 13. Mean population density evolution for the Greece – Bulgaria CBA.

Figure 13 illustrates the temporal evolution of the mean population density of the Greece – Bulgaria CBA. A significant decrease is noted in year 2001, while a gradual rise takes place from that year onwards. Figure 14 shows the spatial distribution at NUTS3 level throughout the CBA, for the year 2008.

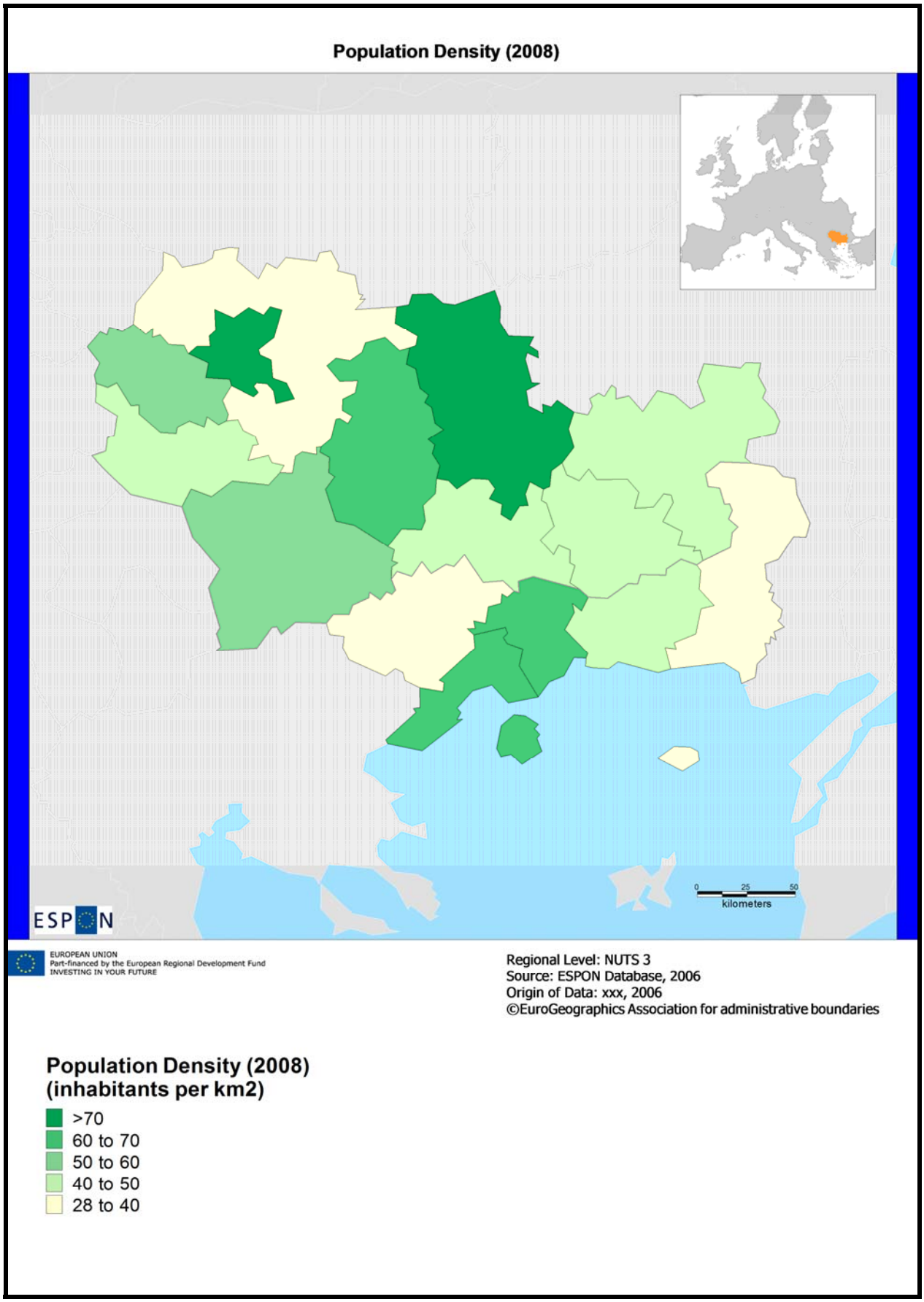

Figure 14. Population density of NUTS3 level units of the Greece – Bulgaria CBA.

2.9. Dependency Ratios

The total demographic dependency ratio is the ratio of the combined youth population (0 to 14 years) and senior population (65 or older) to the working-age population (15 to 64 years). It is expressed as the number of "dependents" for every 100 "workers":

$$Total\ Dependency\ Ratio = \frac{(Number\ of\ \ people\ aged\ 0-14)+(Number\ of\ \ people\ aged\ over\ 65)}{(Number\ of\ \ people\ aged\ \ 15-64)} \quad (6)$$

The (total) dependency ratio can be decomposed into the child dependency ratio and the aged dependency ratio, as:

$$Child\ \ Dependency\ \ Ratio = \frac{(Number\ of\ \ people\ aged\ 0-14)}{(Number\ of\ \ people\ aged\ \ 15-64)} \quad (7)$$

$$Aged\ \ Dependency\ \ Ratio = \frac{(Number\ of\ \ people\ aged\ over\ 65)}{(Number\ of\ \ people\ aged\ \ 15-64)} \quad (8)$$

$$Ageing\ Index = \frac{(Number\ of\ \ people\ aged\ over\ 65)}{(Number\ of\ \ people\ aged\ \ 0-14)} \quad (9)$$

Changes in demographic dependency ratios highlight changes in the age composition of the population.

Table 9 presents the NUTS1, 2, and 3 level units total, child and aged dependency rates together with the ageing index of the Greece – Bulgaria CBA and the EU27 mean values. It occurs that the total dependency ratio of the CBA (47.52) appears slightly lower than the corresponding EU27 value (48.88). The higher total dependency ratio at NUTS3 level unit is found in Drama (GR114, 58.99), in Kavala (GR115, 56.08) and in Evros (GR111, 55.02), increasing the ratio-value for Anatoliki Makedonia, Thraki to 53.88 (significantly higher than the corresponding national value 49.25). Minimum total dependency ratios are found in Sofia (stolitsa) (BG411, 37.75) and Smolyan (BG424, 39.12).

In all NUTS level units of the Greece – Bulgaria CBA, the child dependency ratios were found lower than the aged dependency ratios. This shows that the young population of the CBA represents a smaller portion of total population, as compared to the aged population of the CBA. Higher differences exist in Pernik (BG414, 15.56), Kyustendil (BG415, 14.60), Drama (GR114, 14.06), Evros (GR111, 12.80) and Kavala (GR115, 11.41). These are the NUTS3 areas with the higher ageing indices, leading to an increased mean ageing index for the CBA (1.39), significantly higher than the corresponding EU27 index (1.10).

Table 9. Total, child and aged dependency ratios and ageing indices for the NUTS3 level units of the Greece – Bulgaria CBA.

	CODE	NUTS-ID	Total dependency Ratio	Child dependency Ratio	Aged dependency Ratio	Ageing Index
Bulgaria	BG	NUTS1	44.57	19.39	25.18	1.30
Yugozapaden	BG41	NUTS2	45.11	18.04	27.07	1.52
Sofia (stolitsa)	BG411	NUTS3	37.75	17.44	20.31	1.16
Sofia	BG412	NUTS3	49.59	19.43	30.16	1.55
Blagoevgrad	BG413	NUTS3	40.83	19.72	21.11	1.07
Pernik	BG414	NUTS3	48.15	16.30	31.85	1.95
Kyustendil	BG415	NUTS3	49.22	17.31	31.91	1.84
Yuzhen tsentralen	BG42	NUTS2	43.58	19.28	24.31	1.27
Plovdiv	BG421	NUTS3	44.23	18.92	25.31	1.34
Haskovo	BG422	NUTS3	47.58	19.21	28.36	1.48
Pazardzhik	BG423	NUTS3	44.13	20.78	23.35	1.12
Smolyan	BG424	NUTS3	39.12	16.62	22.50	1.35
Kardzhali	BG425	NUTS3	42.86	20.83	22.03	1.06
Greece	GR	NUTS1	49.25	21.34	27.91	1.31
Anatoliki Makedonia, Thraki	GR11	NUTS2	53.88	22.92	30.96	1.38
Evros	GR111	NUTS3	55.02	21.11	33.91	1.61
Xanthi	GR112	NUTS3	49.64	27.52	22.11	0.80
Rodopi	GR113	NUTS3	49.68	21.16	28.53	1.35
Drama	GR114	NUTS3	58.99	22.47	36.52	1.63
Kavala	GR115	NUTS3	56.08	22.33	33.75	1.51
CBA Total			47.52	20.08	27.45	1.39
EU27			48.88	23.25	25.63	1.10

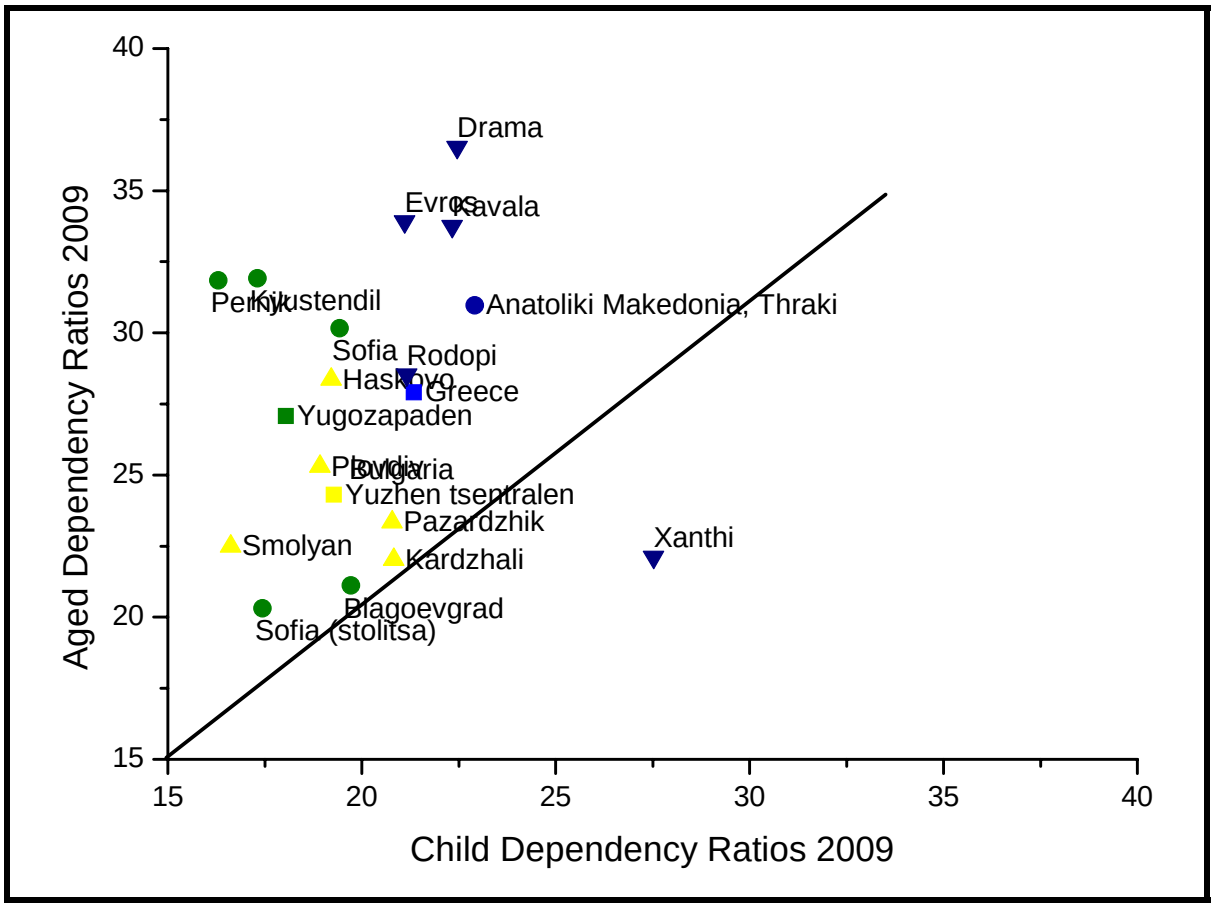

Figure 15. Scatter diagram of child vs. aged dependency ratios for year 2009 in Greece – Bulgaria CBA.

Figure 15 illustrates the scatter diagram of child vs. aged dependency ratios for year 2009 for the Greece – Bulgaria CBA at NUTS0, 2 and 3 level units, showing that Xanthi (GR112) is the only NUTS3 area of the CBA having higher child dependency ratio than the corresponding aged dependency ratio. Areas with higher Aged-to-Child ratios are Pernik (BG414), Kyustendil (BG415), Drama (GR114), Kavala (GR115) and Evros (GR111).

2.10. Border Effect

In general, border regions tend to be disadvantaged economically and with regard to population growth and density. However, the enlargement of the European Union (EU) may create positive border effects in cities or regions located close to the national borders, as they are especially confronted with changes in market access, whereas the border effect for cities or regions further away from the border appears more subdued. This positive integration effect declines with distance, is about the same for new and old members, and is more important for large cities and regions. Following Redding and Sturm (2008), it occurs that:

1. Cities or regions that are close to an abolished border as a result of EU integration shock (in case of EU enlargement) experience a relative population increase,
2. The border effect is different for large and small border cities or regions, and
3. The border effect gets weaker when the distance from the border increases.

In the case of Greece – Bulgaria CBA, the border effect on demography was examined at NUTS4 level units, for cities located at a close distance to the border (maximum road distance of 70 km), in view of the fact that Bulgaria became a full EU member on 1/1/2007. As recent reliable population data for Greece and Bulgaria at NUTS4 level do not exist, population change and population density of these cities was based on demographic data of the period 1991-2001.

Table 10 presents the examined NUTS4 level units located across the Greece – Bulgaria borderline, their population change and density and their road distance to the border (positive for Bulgaria; negative for Greece).

In this analysis, NUTS4 regions were considered as located along the main transport axes along which road distances were determined. Four road axes were considered, the two main border crossing points:

a) the Thessaloniki – Blagoevgrad road axis (part of Pan-European Corridor IV), crossing the borderline at the Promahonas and Kulata checkpoints, expanding along the Blagoevgrad NUTS3 region but outside Anatoliki Makedonia, Thraki Region,

b) the Ardanio – Ormenio – Svilengrad axis (vertical Egnatia axis and part of the Pan-European Corridor IX),

and the two newer crossing points:

c) the Drama - Exohi – Hadzhidimovo axis constructed in 2005, and

d) the Xanthi - Thermes – Zlatograd axis opened in 2009.

The Komotini – Nimfaia – Kurdjali axis has not been completed yet; therefore the interaction between Komotini and Haskovo is limited.

Table 10. Population change, population density and road distance to the border line (positive for Bulgaria; negative for Greece), along the main Greece – Bulgaria transport axes, for the NUTS4 level units of the Greece – Bulgaria CBA.

Transport Axis	NUTS4 level unit	Annual Population Change (%)	Population Density (inh per sq km)	Road distance to border (km)
Strymon Axis	Petrich	0.09	85.96	11
Strymon Axis	Sandanski	0.27	392.28	18
Strymon Axis	Kresna	-0.97	16.3	38
Strymon Axis	Simitli	-0.55	28.14	56
Strymon Axis	Blagoevgrad	-0.19	121.98	70
Exohi-Hadzhidimovo Axis	Hadzhidimovo	-1.04	30.39	7
Exohi-Hadzhidimovo Axis	Satovcha	-0.73	51.35	10
Exohi-Hadzhidimovo Axis	Gotse Delchev	-0.27	100.24	22
Exohi-Hadzhidimovo Axis	Bansko	-0.8	25.87	41
Exohi-Hadzhidimovo Axis	Razlog	-0.11	48.59	56
Exohi-Hadzhidimovo Axis	Belitsa	-0.56	32.56	62
Exohi-Hadzhidimovo Axis	Yakoruda	-0.95	30.53	67
Exohi-Hadzhidimovo Axis	Borino	-1.06	21.66	99
Exohi-Hadzhidimovo Axis	Devin	-0.94	24.14	105
Exohi-Hadzhidimovo Axis	Dospat	-0.72	37.36	109
Exohi-Hadzhidimovo Axis	Kato Nevrokopi	-0.73	9.19	-11
Exohi-Hadzhidimovo Axis	Prosotsani	1.61	26.77	-45
Exohi-Hadzhidimovo Axis	Sitagroi	1.39	83.73	-53
Thermes - Zlatograd Axis	Banite	-2.59	16.63	38
Thermes - Zlatograd Axis	Zlatograd	-1.29	68.68	5
Thermes - Zlatograd Axis	Madan	-1.12	72.03	28
Thermes - Zlatograd Axis	Nedelino	-1.24	74.07	14
Thermes - Zlatograd Axis	Rudozem	-1.96	51.23	34
Thermes - Zlatograd Axis	Smolyan	-0.47	49.13	56
Thermes - Zlatograd Axis	Chepelare	-0.5	20.95	70
Thermes - Zlatograd Axis	Miki	0.45	36.18	-21
Thermes - Zlatograd Axis	Xanthi	4.19	341.38	-40
Thermes - Zlatograd Axis	Stavroupolis	-2.25	9.04	-46
Kardzhali - No Axis	Ardino	-0.53	37.32	33
Kardzhali - No Axis	Dzhebel	0.35	36.21	32
Kardzhali - No Axis	Kirkovo	-0.84	36.91	32
Kardzhali - No Axis	Krumovgrad	-0.68	21.33	63
Kardzhali - No Axis	Kardzhali	-0.05	109.83	98
Kardzhali - No Axis	Momchilgrad	-0.51	52.91	45
Ormenio – Svilengrad axis	Dimitrovgrad	-1.77	100.85	72
Ormenio – Svilengrad axis	Ivaylovgrad	-1.85	8.30	57
Ormenio – Svilengrad axis	Ljubimec	-0.78	31.04	13
Ormenio – Svilengrad axis	Madzharovo	-2.64	7.30	63
Ormenio – Svilengrad axis	Svilengrad	-0.57	34.23	7
Ormenio – Svilengrad axis	Simeonovgrad	-1.01	42.02	43
Ormenio – Svilengrad axis	Harmanli	-0.79	37.16	30
Ormenio – Svilengrad axis	Haskovo	-0.52	130.93	55
Ormenio – Svilengrad axis	Vissa	-1.46	48.09	-35
Ormenio – Svilengrad axis	Orestiada	1.75	84.59	-43
Ormenio – Svilengrad axis	Didimotiho	-0.46	53.65	-61

Road distance to border was considered positive from the Bulgarian side and negative from the Greek side of the borderline.

By applying the border effect multiple linear regression equation (eq. (1)), relating population growth rate to population density and road distance to border, for the Ormenio – Svilengrad axis, we obtain a positive although statistically non-significant relation of population growth to population density and a negative, statistically significant ($p<0.05$) relation between population growth and border road distance (Table 11).

Table 11. Model coefficients for the Multiple Linear Regression Model between annual population growth and population density and road distance to border along the Ormenio – Svilengrad axis.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.308	0.447		-2.924	0.019
	PopDens	0.013	0.007	0.430	1.850	0.101
	BorderDistance	-0.015	0.006	-0.613	-2.637	0.030

a. Dependent Variable: AnnPopGrowth

This statistically significant linear regression ($p = 0.035<0.05$; $R = 0.753$ and $R^2 = 0.567$) depicts that as one moves away the border along the positive part of the road axis (Bulgaria), the population growth of NUTS4 level units obtains high negative values, while when moving along the negative part of the axis (Greece), population growth obtains slightly positive values (Figure 16).

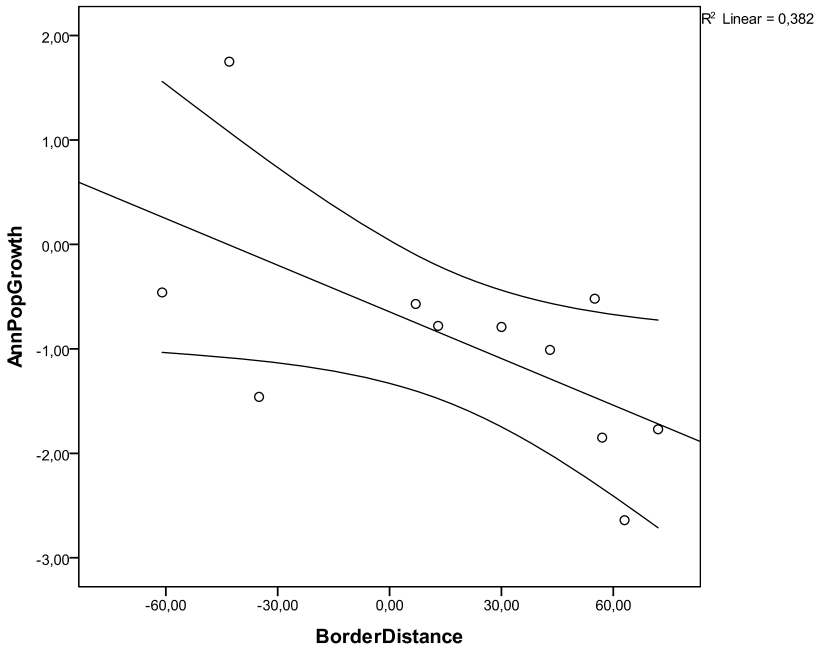

Figure 16. Linear regression between NUTS4 population growth and border road distance along the Ormenio – Svilengrad axis.

Repeating the analysis for the newly constructed Exohi-Hadzhidimovo Axis, similar results are produced, as shown in Table 12. The statistically significant negative correlation of NUTS4 level units population growth to border road distance describes the high negative values of population growth when moving towards the positive part of the axis (Bulgaria), and the opposite behavior towards Greece. The regression is statistically significant ($p=0.025<0.05$; $R = 0.724$; $R^2 = 0.523$).

Table 12. Model coefficients for the Multiple Linear Regression Model between annual population growth and population density and road distance to border along the Exohi-Hadzhidimovo axis.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-0.158	0.420		-0.377	0.714
	PopDens	0.006	0.008	0.162	0.708	0.495
	BorderDistance	-0.011	0.004	-0.657	-2.866	0.017

a. Dependent Variable: AnnPopGrowth

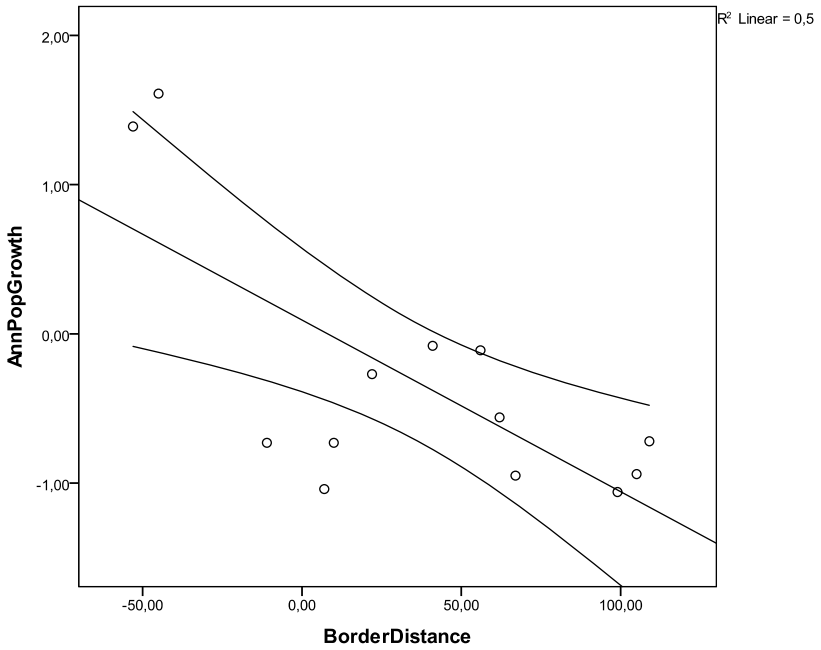

Figure 17. Linear regression between NUTS4 population growth and border road distance along the Exohi-Hadzhidimovo axis.

An exactly opposite behavior is seen along the newly opened Thermes - Zlatograd Axis. Population growth appears positively related to population density and distance to border, with statistical significance only with the first parameter (Table 13).

Table 13. Model coefficients for the Multiple Linear Regression Model between annual population growth and population density and road distance to border along the Thermes - Zlatograd Axis.

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.977	0.529		-3.733	0.007
	PopDens	0.018	0.004	0.884	4.195	0.004
	BorderDistance	0.002	0.010	0.045	0.213	0.837

a. Dependent Variable: AnnPopGrowth

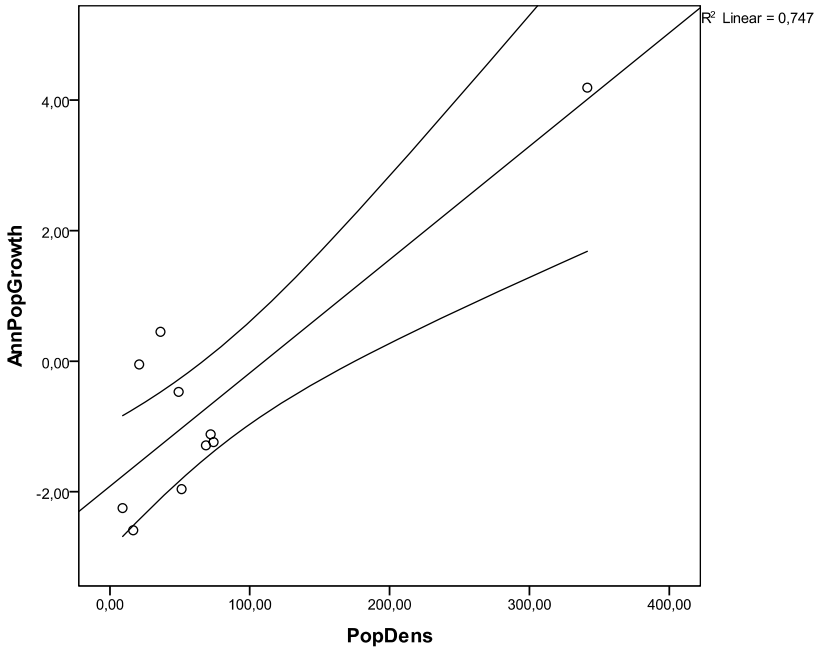

Figure 18. Linear regression between NUTS4 population growth and population density along the Exohi-Hadzhidimovo axis.

From the above analysis, it occurs that along old and well-established transport axes the border affects population change positively, thus attracting population. Population growth was positive from the Greek side along the Ormenio – Svilengrad and the Exohi - Hadzhidimovo axes. Settlements near the border from the Bulgarian side depicted near-zero to slightly negative population growth rates. As distance to border increases these negative growth rates appear enhanced, indicating the positive border effect. Along newly opened crossings, these dynamics are absent and population growth appears mostly related to the population density of these settlements.

2.11. Chapter Conclusions

- The Greece – Bulgaria CBA covers the north-eastern part of Greece and the southern part of Bulgaria. It comprises of three NUTS administrative regions: Yugozapaden (BG41), Yuzhen tsentralen (BG42) and Anatoliki Makedonia, Thraki (GR11). The total CBA area is 56,828.40 sq km, comprised of 39% by Yuzhen tsentralen, 35% by Yugozapaden and 25% by Anatoliki Makedonia, Thraki.
- Demographic analysis of the Greece – Bulgaria CBA was performed on the total population, population density, population fertility, population change factors and child and aged dependency ratios. Along the main transport axes, the border effect was examined on population growth and density.
- The total population of the Greece – Bulgaria CBA represents approximately 0.85% of the total EU27 population. Yugozapaden accounts for almost 50% of CBA's total population, Yuzhen tsentralen about 36% and Anatoliki Makedonia, Thraki approximately 14%.
- Total Population in the CBA decreases over time by approximately 4.3%, within the latest decade, with the highest negative trend shown by Yuzhen tsentralen. Xanthi (GR113) and Sofia stolitsa (BG111) are the only NUTS3 areas of the CBA depicting population growth higher than the EU27 average growth rate. Net migration is responsible for the population increase in Sofia (stolitsa) (BG411), while natural increase for the population growth in Xanthi (GR113). Population reduction due to natural causes is shown in Plodviv (BG421), Drama (GR114) and Kavala (GR115). In all other NUTS3 unit levels of the Greece – Bulgaria CBA population decrease is due to both natural causes and net migration.
- The mean fertility rate for the CBA is 1.48, equal to the corresponding rate of Bulgaria and slightly lower to that of Greece (1.51), but significantly lower than that of EU27 (1.60). The temporal evolution shows a gradual increase of fertility rates in all regions of the CBA; Anatoliki Makedonia, Thraki has the higher fertility rate value (1.61).
- Population density in the CBA (111.4 inhabitants per sq. km) is significantly higher than the mean value in Bulgaria (68.7 inhabitants per sq km) and Greece (85.9 inhabitants per sq km), but of the same order with the EU27 mean value.
- In all NUTS3 level units of the Greece – Bulgaria CBA, the child dependency ratios were found lower than the aged dependency ratios. This shows that the young population of the CBA represents a smaller portion of total population, as compared to the aged population of the CBA. The most over-aged population is found in Drama (GR114), Evros (GR111), Kavala (GR115), Pernik (BG414), and Kyustendil (BG415).

- Along the well-established transport axes of Ormenio – Svilengrad and Exohi – Hadzhidimovo, the border affects population change positively, thus attracting population. Population growth was positive from the Greek side along these axes, turning to slightly negative towards the Bulgarian side. As distance to border increases, population growth becomes strongly negative, indicating the positive border effect. Along newly opened crossings, these dynamics are absent and population growth appears mostly related to the population density of these settlements.

Chapter 3 – Polycentric Development

3.1. Aims, Indicators and Methods

The concept of polycentric development has gained widespread currency in planning and territorial development strategies, and today plays a fundamental role in European regional policy through ESDP (European Spatial Planning Perspective). According to this, certain forms of spatial organization appear better structured than others, meaning that the polycentric distribution of people, activities and infrastructures is better than the monocentric. The notion of 'territorial balance' suggests that we find strongly developing cities all across the national territory, not just in one part of the country.

Today, the concept of polycentricity plays a fundamental role in European regional policy and constitutes a priority for spatial development in Europe. Polycentricity can contribute to the economic, social and territorial cohesion, which constitutes one of the objectives of the Lisbon Treaty, as well as to the economic competitiveness, social justice and sustainable development. Especially for South-Eastern Europe, it is strongly believed that the existing or emerging polycentric structures should be strengthened by improving the accessibility of medium-sized centres and counterbalancing the reduced accessibility of rural and isolated regions (Spiekermann and Wegener, 2006).

Based on ESPON Metroborder Project, polycentricity has a twofold feature:

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

Both elements are strongly linked: relations between cities are crucial for polycentricity, as nodes without relations would not form a polycentric system.

The main aim of this chapter is to identify tendencies in the structure of the city network in the Greece – Bulgaria Cross-Border Area (CBA) and compare the urban network density to that in the non-border regions. Further, to examine the deviation of urban centres in the CBA from the rank-size distribution of EU27 and determine the impact of urban centres distribution on commuting patterns. The basic indicators in this analysis involve:

a) the size polycentricity index, with four sub-indicators,

1. Slope of the regression line of the rank-size distribution of population in the Functional Urban Areas of the Greece – Bulgaria CBA,
2. Primacy rates in terms of the population distribution in the Functional Urban Areas of the Greece – Bulgaria CBA,
3. Slope of the regression line of the rank-size distribution of GDP in the Functional Urban Areas of the Greece – Bulgaria CBA,
4. Primacy rates in terms of the GDP in the Functional Urban Areas of the Greece – Bulgaria CBA.

b) the location index, expressed as the Gini coefficient of the size of the Thiessen polygons around each FUA,

c) the connectivity index with two sub-indicators,

1. Slope of the regression line between the accessibility and the FUAs population,
2. the Gini coefficient of the accessibility of the FUAs.

3.2. Concepts

Two concepts have been developed by ESPON as a basis for the description and typology of the urban network in Europe:

a) The Functional Urban Area (FUA), consisting of an urban area or a municipality in the core and adjacent commuting areas surrounding this core. For countries with more than 10 million inhabitants, as in the case of Greece and Bulgaria, a FUA is defined as having an urban core of at least 15,000 inhabitants and over 50,000 in total population.

b) The Metropolitan European Growth Area (MEGA), corresponding to FUAs with the highest average score in respect to population, transport, manufacturing, knowledge and decision making.

Two additional concepts have been coined in order to analyse the territorial context of cities and the potentials for polycentric integration based on morphological proximity:

c) PUSH (Potential Urban Strategic Horizon): PUSH areas include all municipalities of which at least 10% of the area can be reached within 45 minutes from each FUA centre by car. There are as many PUSH areas as there are FUAs. PUSH areas of neighbouring FUAs can overlap.

d) PIA (Potential Polycentric Integration Area): PIAs have been constructed by merging the PUSH areas of neighbouring cities, if the, demographically speaking, smaller one shares at least 1/3 of its PUSH area with the larger

one. Each PUSH area belongs to one PIA only, the largest neighbouring city being preferred when there are multiple overlaps. Multiple tiers of integration can occur within a single PIA. Neighbouring PIAs can overlap.

Present methodology for polycentric development analysis involves the log-linear rank size distribution, comparing a hypothetical homogeneous distribution of FUAs with the actual distribution, the calculation of primacy rates and the analysis of commuting flows. The log linear rank-size distribution can be represented as a straight regression line with a given slope. It can be hypothesised that a relatively flat line represents a relatively polycentric national urban system, whereas a very steep line represents a more monocentric national urban system (Nordregio et al., 2004). This means that the log linear rank-size distribution can be considered an indicator of the degree of polycentricity of the urban system.

3.3. Functional Urban Areas in Greece and Bulgaria

Functional Urban Areas have been academically defined in Greece, although the definition of 'new urban municipality' after the Kapodistrias and Kallikratis municipality reforms appears quite similar to that of ESPON 1.1.1. The main problem arises from the fact that Greek authorities used mostly political criteria instead of technical for the definition of these urban centres. 45 FUAs were defined in Greece. 1 FUA is considered as MEGA (Athens), 7 FUAs are considered of transnational or national significance, while the remaining 37 FUAs are considered of local or regional significance. The country is mostly dominated by Athens and has Thessaloniki as a second city, while other FUAs are considerably smaller. The average FUA population in Greece is 154,312 inhabitants, while 65% of inhabitants live in FUAs. In Greece almost all FUAs are growing, with the smallest growing relatively faster.

In Bulgaria the concept of FUAs has not yet been applied. According to national experts the best proxy is the municipality level (NUTS5). In Bulgaria 31 FUAs have been determined. 1 FUA (Sofia) is considered as MEGA, 3 FUAs are considered of transnational or national significance, while the remaining 27 of local or regional significance. Similarly to Greece, Bulgaria is rather monocentric, with the capital Sofia as the dominant city. Bulgaria has two other medium-sized cities. The remaining FUAs have less than 200,000 inhabitants. The average FUA population in Bulgaria is 155,291 inhabitants. 63% of inhabitants live in FUAs. All FUAs are demographically declining with the smallest loosing most of their population.

Table 14. List of FUAs for Bulgaria, FUAs, PUSH and PIAs population and cities status in regard to PIAs.

Name	FUA Population	PUSH Population	PIA population	PIA Status
SOFIA	1,173,811	1,519,028	1,604,674	1
PLOVDIV	1,721,905	874,153	1,094,300	1
VARNA	320,464	615,078	675,424	1
BURGAS	209 417	366 366	366,366	3
RUSE	178,379	523,151	846,739	1
STARA ZAGORA	167,661	483,826	917,657	1
PLEVEN	149,142	402,420	497,630	1
SLIVEN	136,148	372,835	439,069	1
PAZARDZHIK	127,900	812,915	1,094,300	2
DOBRICH	125,721	616,795	675,424	2
PERNIK	104,625	1,510,003	1,604,674	2
SHUMEN	104,456	340,663	440,165	1
HASKOVO	99,181	370,284	535,823	1
YAMBOL	95,000	355,717	439,069	2
VELIKO TARNOVO	90,432	404,206	577,924	1
VRACA	85,215	335,461	444,497	1
KAZANLAK	81,533	460,522	917,657	2
BLAGOEVGRAD	78,133	205,984	205,984	3
VIDIN	77,480	231,363	231,363	3
GABROVO	74,930	464,298	577,924	2
KYUSTENDIL	70,573	176,658	1,604,674	2
KARLOVO	70,278	623,466	917,657	2
KARDZHALI	69,830	411,472	535,823	2
DIMITROVGRAD	64,852	555,222	917,657	2
LOVECH	62,165	357,682	497,630	2
SILISTRA	61,942	298,499	420,720	2
MONTANA	61,422	351,988	444,497	2
TARGOVISHTE	60,890	400,699	440,165	2
RAZGRAD	58,874	621,645	846,739	2
PETRICH	57,689	198,201	198,201	3
ASENOVGRAD	52,116	876,792	1,094,030	2

Tables 14 and 15 provide a list of FUAs for Greece and Bulgaria, sorted according to FUA population per country (up to 50,000 inhabitants), and indicating the status of the city with regards to PIAs, as well as the population in the corresponding PUSH area and PIA.

Table 15. List of FUAs for Greece, FUAs, PUSH and PIAs population and cities status in regard to PIAs.

Name	FUA Population	PUSH Population	PIA population	PIA Status
ATHINAI	3,761,810	3,645,055	3,905,718	1
THESSALONIKI	1,057,825	1,293,870	1,538,694	1
PATRAI	197,663	382,232	399,682	1
IRAKLION	154,801	252,290	252,290	3
LARISA	126,076	571,307	596,087	1
VOLOS	82,439	365,468	596,087	2
IOANNINA	70,203	203,246	203,246	3
KAVALA	63,293	317,644	459,600	1
LAMIA	58,601	179,622	179,622	3
KALAMATA	57,620	238,597	358,791	1
KATERINI	56,434	944,142	197,564	1

SERRAI	56,145	243,600	243,600	3
DRAMA	55,632	266,547	459,600	2
AGRINION	54,253	208,851	208,851	3
RODHOS	53,709	112,694	112,694	3
CHALKIS	53,584	657,648	905,718	2
CHANIA	53,373	179,394	212,891	1
ALEXANDROUPOLIS	52,720	161,156	269,828	1
KOMOTINI	52,659	245,032	269,828	2
XANTHI	52,270	293,971	459,600	2
TRIKALA	51,862	398,423	441,151	1

3.4. Functional Urban Areas in the Greece – Bulgaria CBA

The Functional Urban Areas of the Greece – Bulgaria Cross-Border Area are presented in Table 16. The Table provides information on the FUAs area, their population in 2001 and 2006, the population growth and the GDP per inhabitant for each FUA. Table 17 presents the NUTS3 level units of the Greece – Bulgaria CBA, their number in FUAs and their 2006 total population and population share within FUA in each NUTS3 level unit.

It occurs that Sofia (stolitsa) is the main urban centre in the Greece – Bulgaria CBA, having higher population share in FUA than the total NUTS3 level unit population (107.3%). Plovdiv (BG421) and Haskovo (BG422) have 2 FUAs representing 68.7% and 59.4% of their NUTS3 level unit population within these FUAs. The rest CBA appears well-balanced with almost equal total population (70-90,000 inhabitants) in FUAs.

Table 16. FUAs of the Greece – Bulgaria CBA, FUA area, population, population change and GDP per inhabitant.

Name	NUTS3 - ID	FUA-ID	Status	FUA Area (km^2)	Population 2001	Population 2006	Population Growth (%)	GDP per inhabitant
SOFIA	BG411	BG10067	1	4066	1,272,116	1,328,089	4.4	7,000
BLAGOEVGRAD	BG413	BG10043	3	1173	92,996	90,578	-2.6	2,000
PETRICH	BG413	BG10059	3	7	3,302	3,216	-2.6	2,000
PERNIK	BG414	BG10058	2	484	104,248	97,993	-6.0	3,000
KYUSTENDIL	BG415	BG10054	2	1399	74,873	70,231	-6.2	2,000
PLOVDIV	BG421	BG10061	1	1227	439,061	434,231	-1.1	3,000
ASENOVGRAD	BG421	BG10042	2	76	51,936	51,365	-1.1	3,000
HASKOVO	BG422	BG10050	1	740	98,693	94,745	-4.0	2,000
DIMITROVGRAD	BG422	BG10045	2	567	64,852	62,258	-4.0	2,000
PAZARDZHIK	BG423	BG10057	2	37	78,855	75,780	-3.9	3,000
KARDZHALI	BG425	BG10051	2	29	45,659	44,244	-3.1	2,000
ALEXANDROUPOLIS	GR111	GR10585	1	807	56,498	60,842	7.7	13,000
XANTHI	GR112	GR10606	2	505	76,383	76,493	0.1	12,000
KOMOTINI	GR113	GR10595	2	932	68,762	69,824	1.5	10,000
DRAMA	GR114	GR10587	2	1212	71,860	76,176	6.0	12,000
KAVALA	GR115	GR10592	1	628	92,356	92,558	0.2	14,000

Table 17. Number of FUAs and share of population in FUAs for each NUTS3 area of the Greece – Bulgaria CBA.

Region name	Region code (NUTS 3)	Typology on polycentricity	No. of FUAs in NUTS3	Population in FUA (2006)	Share of population within FUAs in each NUTS 3 (%)
Sofia (stolitsa)	BG411		1	1,328,089	107.29
Sofia	BG412		0	0	0
Blagoevgrad	BG413		2	93,794	28.42
Pernik	BG414		1	97,993	70.16
Kyustendil	BG415		1	70,231	46.57
Plovdiv	BG421		2	485,596	68.74
Haskovo	BG422		2	157,003	59.40
Pazardzhik	BG423		1	75,780	25.58
Smolyan	BG424		0	0	0
Kardzhali	BG425		1	44,244	28.10
Evros	GR111		1	60,842	40.81
Xanthi	GR112		1	76,493	72.23
Rodopi	GR113		1	69,824	62.73
Drama	GR114		1	76,176	75.65
Kavala	GR115		1	92,558	65.92

3.5. Population Primacy Rate

Characteristic for a polycentric national urban system is that no city dominates over other cities in economic, cultural and other respects. In other words, a polycentric urban system lacks strong hierarchy. Rather, characteristic for polycentric urban systems is that cities often tend to be relatively similar-sized. For the FUAs population, a linear regression of the absolute value of the size of each city and of the corresponding location of the city in the size rating is performed. The city that is classified first in the size rating is excluded from this linear regression. The regression slope constitutes an indicator of the equidistribution of the population. Apart from this, we need to calculate the primacy rate of the city that is first in the rating scale. This is done by dividing the size of the city that is first in the rating by the hypothetical value that the size of the city would acquire if it followed the linear regression.

In the hypothetical situation of an absolutely polycentric system, the regression slope would have a zero inclination and the primacy rate for population will be one. This means that all FUAs have almost the same population. The more the regression slope increases, the more dependant are the sizes' values from the rating position and the larger the disparities between FUAs, while the higher the primacy rate is, the greater the difference between the largest and the rest of the FUAs. Table 18 presents the FUAs population and ranking for years 2001 and 2006. Obviously, the Greece – Bulgaria CBA is characterized by a clear dominance of Sofia (stolitsa), as far as its population size is concerned, both for the years 2001 and 2006. Apart of Sofia, it occurs that Plovdiv, Pernik, Haskovo and Blagoevgrad consist the first five FUAs of the examined area. However, in 2006 Kavala appears in the fifth rank position, due to population increase of 1.09%. The rating of FUAs depicts significant changes between positions 6 to 10. The highest positive population change was shown by Alexandroupolis (+8.93%) and Drama (+5.56%), while the highest negative population change by Pernik (-5.77%). The FUA of Xanthi remained unchanged within the examined period.

Figure 19 presents the FUAs population and population change (2001-06) for the Greece – Bulgaria CBA.

Figure 19. Population and Population Change of FUAs in the Greece – Bulgaria CBA.

Table 18. FUAs population and ranking for 2001 and 2006

Region name	Population 2001 (ths)	Ranking 2001	Population 2006 (ths)	Ranking 2006	Population Change (%)
Sofia (stolitsa)	1,272	1	1,328	1	+4.40
Plovdiv	439	2	434	2	-1.14
Pernik	104	3	98	3	-5.77
Haskovo	99	4	95	4	-4.04
Blagoevgrad	93	5	91	6	-2.15
Kavala	92	6	93	5	+1.09
Pazardzhik	79	7	76	9	-3.80
Xanthi	76	8	76	7	0.00
Kyustendil	75	9	70	10	-3.80
Drama	72	10	76	8	+5.56
Komotini	69	11	70	11	+1.45
Dimitrovgrad	65	12	62	12	-4.62
Alexandroupolis	56	13	61	13	+8.93
Asenovgrad	52	14	51	14	-1.92
Kardzhali	46	15	44	15	-4.35

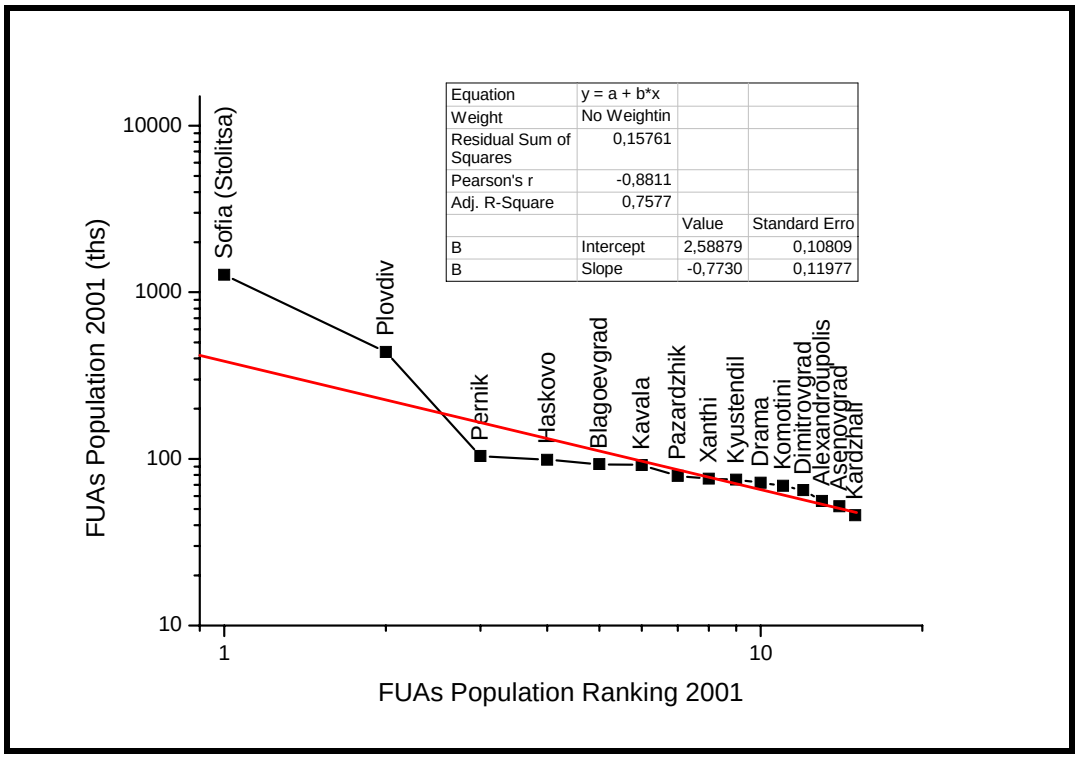

Figure 20. Rank-size distribution of FUAs population in the Greece – Bulgaria CBA for year 2001.

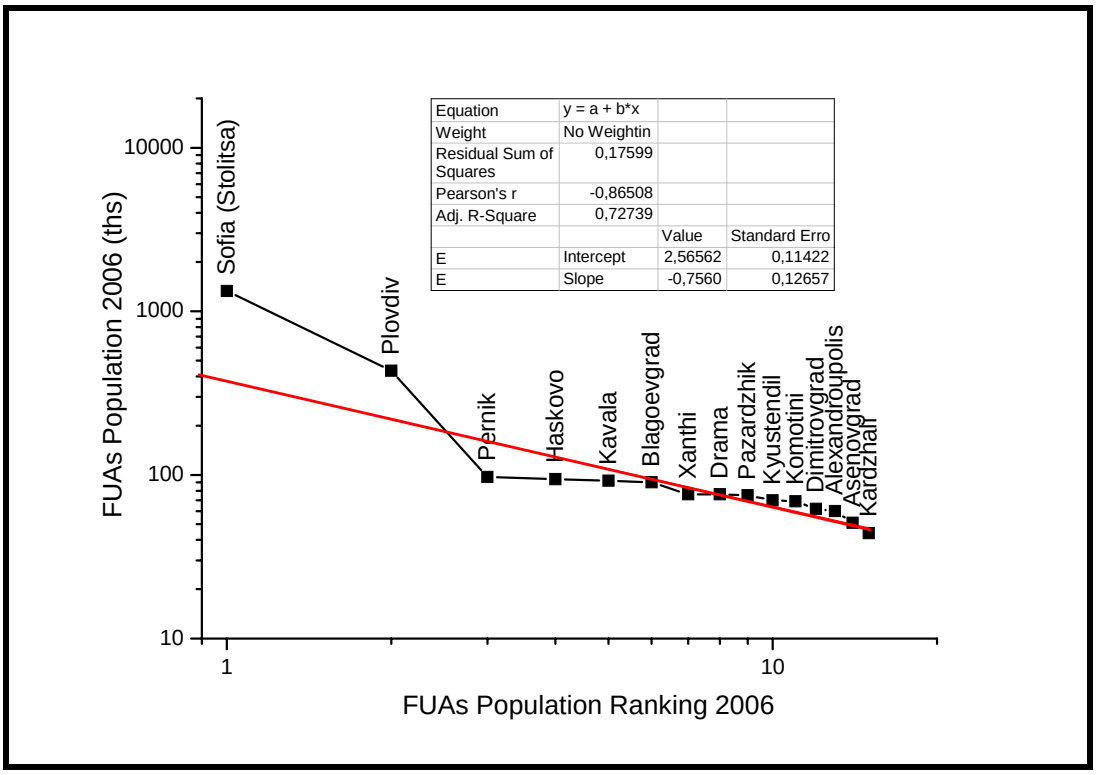

Figure 21. Rank-size distribution of FUAs population in the Greece – Bulgaria CBA for year 2006.

Figures 20 and 21 are built to examine the presence of trend towards a more polycentric or a more monocentric structure in the Greece – Bulgaria CBA for years 2001 and 2006, respectively. The performance of a linear regression between the population of the FUAs and their location in the aforementioned classification results in the indicator "primacy rate", which expresses the degree of primacy of the FUA with the highest population (in this case Sofia).

The value of the primacy rate for the Greece – Bulgaria CBA was 3.35 in 2001, increasing to 3.66 in 2006. This means that the population primacy of Sofia FUA in relation to the rest of the FUAs in the Greece – Bulgaria CBA appears to be increasing in the period 2001-2006. By solving the produced regression equation, we find that based on the population distribution of the CBA, the population of Sofia should be approximately at the level of 380,189 inhabitants in 2001 and 363,078 inhabitants in 2006, to achieve polycentricity. Moreover, based on the distribution of cities in relation to the regression line, it occurs that Plovdiv is over-represented, while the medium sized cities of the CBA (Pernik, Haskovo and Kavala) are under-represented.

The slope of the regression line in the rank-size distribution depicts a rather polycentric pattern in the distribution of population in the Greece – Bulgaria CBA. A slope of -0.77 to -0.75 appears similar to the most polycentric countries in EU, as Hungary (-0.67). The change in the slope of this regression line shows a slight reduction from -0.77 in the year 2001 to -0.75 in year 2006, meaning that the system moves slowly towards a more monocentric pattern. This trend is mainly due to the population increase of Sofia FUA, which appears relatively higher than the corresponding population increase evident in the Greek FUAs with relatively small size, located exactly in the middle of the rating between positions 6 and 13, such as the FUAs of Kavala, Drama, Komotini and Alexandroupolis.

3.6. GDP Primacy Rate

The Gross Domestic Product (GDP) is used to express the FUAs size of the markets. GDP per inhabitant data for all European FUAs for year 2006 are provided by Eurostat. The values of this parameter were multiplied by the 2006 FUAs population to derive the 2006 FUAs GDP. It occurs that the FUAs of the Greece – Bulgaria CBA produce a GDP of 16,615,868,000 euros with a mean GDP per FUA of 1,107,724,000 euros. The highest GDP is produced in the FUA of Sofia (9,296,623,000 euros), followed by Plovdiv (1,302,693,000 euros) and Kavala (1,295,812,000 euros). FUAs with the lower GDPs are Kardzhali (88,488,000 euros), Dimitrovgrad (124,516,000 euros) and Kyustendil (140,462,000 euros). Figures 22 and 23 illustrate the distribution of FUAs GDP and GDP per inhabitant (year 2006) for the Greece – Bulgaria CBA.

The methodology of analysis to obtain the GDP size index is the same as the one applied for population: Initially, the FUAs are rated on the basis of their location hierarchy and then follows a linear regression between the FUAs' GDP and their location in this rating.

Table 19. FUAs GDP per inhabitant and GDP in year 2006.

Region name	FUA GDP per inhabitant (ths euros)	FUA Population 2006	FUA GDP (million euros) 2006
Sofia (stolitsa)	7	1,328,089	9,296
Blagoevgrad	2	90,578	181.2
Pernik	3	97,993	294.0
Kyustendil	2	70,231	140.5
Plovdiv	3	434,231	1,302.7
Asenovgrad	3	51,365	154.1
Haskovo	2	94,745	189.5
Dimitrovgrad	2	62,258	124.5
Pazardzhik	3	75,780	227.3
Kardzhali	2	44,244	88.5
Alexandroupolis	13	60,842	790.9
Xanthi	12	76,493	917.9
Komotini	10	69,824	698.2
Drama	12	76,176	914.1
Kavala	14	92,558	1,295.8

Table 20. FUAs GDP and ranking.

Region name	FUA GDP 2006 (million euros)	Ranking
Sofia (stolitsa)	9,297	1
Plovdiv	1,303	2
Kavala	1,296	3
Xanthi	918	4
Drama	914	5
Alexandroupolis	791	6
Komotini	698	7
Pernik	294	8
Pazardzhik	227	9
Haskovo	189	10
Blagoevgrad	181	11
Asenovgrad	154	12
Kyustendil	140	13
Dimitrovgrad	125	14
Kardzhali	88	15

The application of the log-linear regression results in a "primacy rate" indicator that expresses the degree of prevalence of the FUA with the highest GDP (Sofia) (Figure 24). In 2006, the value of this indicator for Sofia was only 0.20, meaning that Sofia excels a rather weak economic primacy over the rest of the FUAs of the Greece – Bulgaria CBA. Based on the distribution of the GDP in the FUAs of the examined area, and expanding the produced regression line, a GDP of 6,606,934,000 euros will be needed to reduce primacy. The regression slope in the GDP of the FUAs (-1.47 in 2006) shows a more balanced distribution of FUAs over the CBA territory.

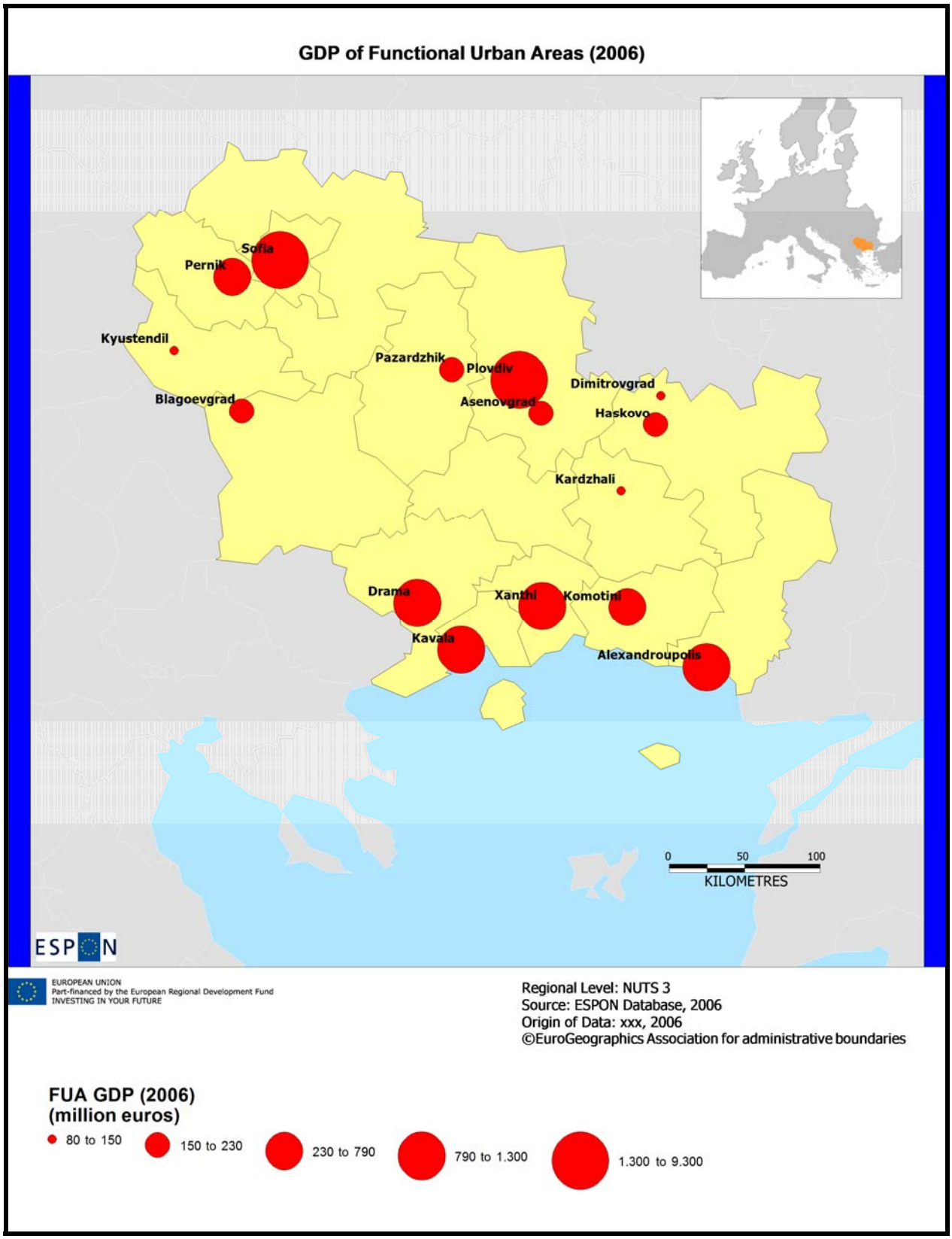

Figure 22. Distribution of FUAs GDP throughout the Greece – Bulgaria CBA.

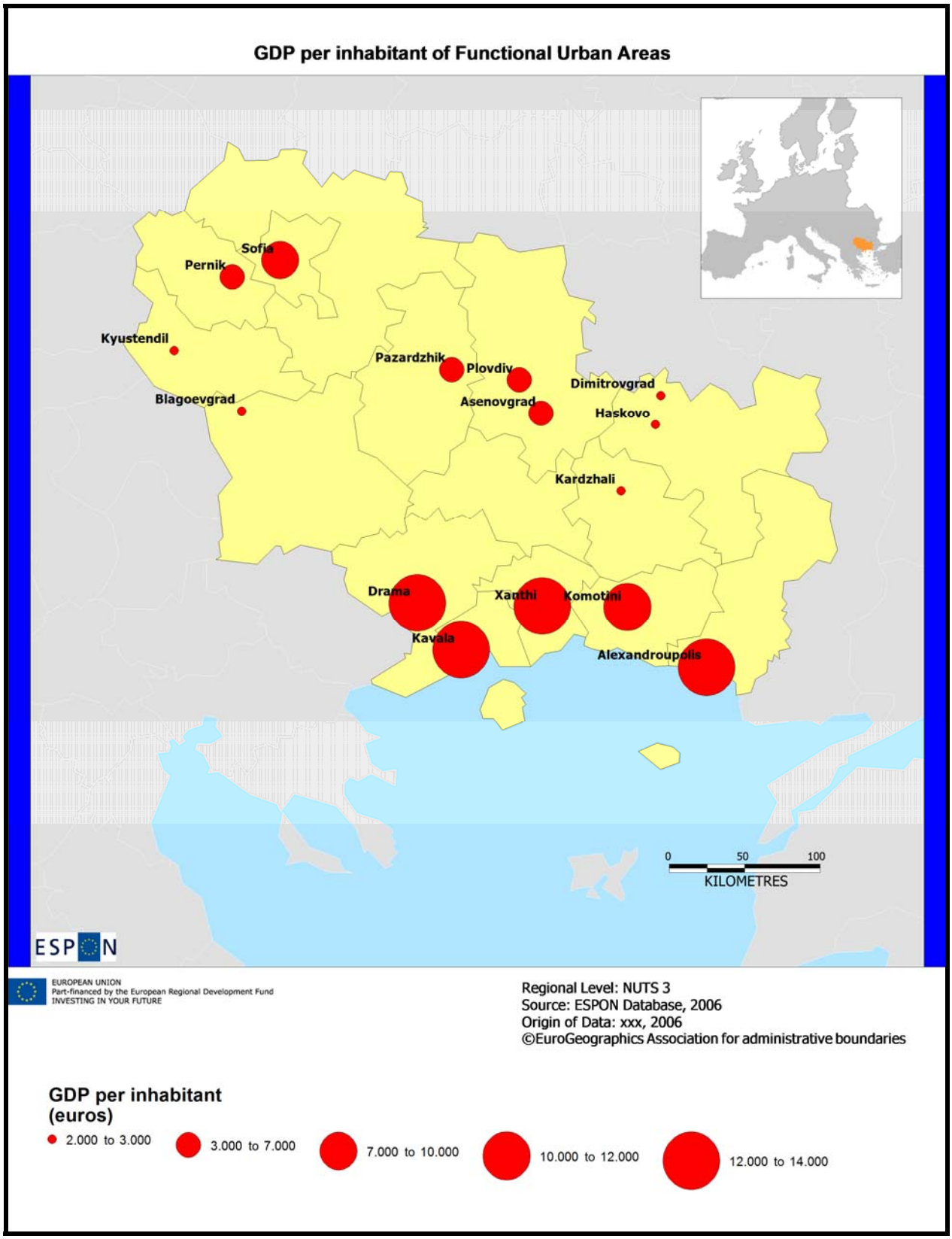

Figure 23. Distribution of FUAs GDP per inhabitant throughout the Greece – Bulgaria CBA.

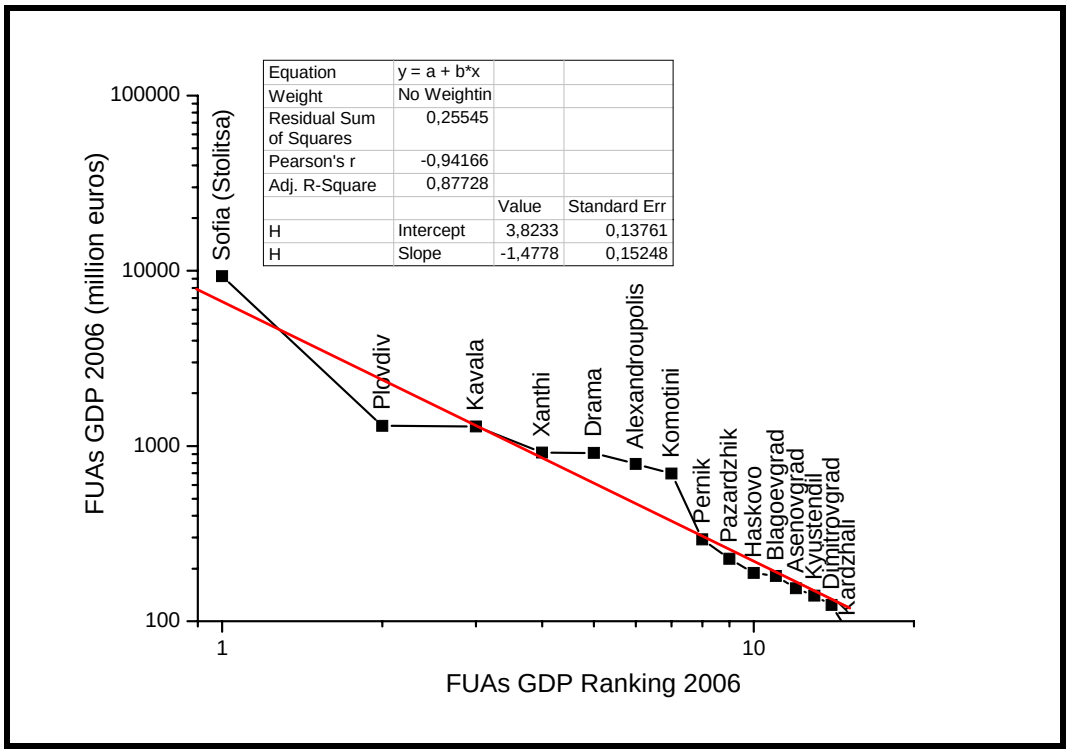

Figure 24. Rank-size distribution of FUAs GDP in the Greece – Bulgaria CBA for year 2006.

Table 21. Polycentricity Size Indicators for Greece – Bulgaria CBA.

NUTS Area (Code)	No. of FUAs	Rank-size distribution of population 2006		Rank-size distribution of GDP 2006	
		Slope	Primacy	Slope	Primacy
Bulgaria	31	-0.78	1.54	-0.90	2.31
Greece	45	-0.89	6.00	-0.96	6.13
Voreia Ellada (GR1)	20	-0.63	5.75	-0.69	6.87
Kentriki Ellada (GR2)	16	-0.59	1.62	-0.61	1.45
N. Aigaiou – Kriti (GR4)	8	-0.92	1.25	-1.04	0.98
Greece – Bulgaria CBA	15	-0.75	3.66	-1.47	0.20

The fact that the GDP rank-size distribution is similar to that of population proves the general principle that 'largest cities are most likely to be most economically successful' (ESPON, 2005). As a consequence, disparities between cities or

categories of cities tend to be larger in terms of economic development than in terms of population development (Meijers et al., 2007).

Comparative results of the polycentricity size indicators for Greece – Bulgaria CBA and the respective NUTS0 and NUTS1 unit levels are shown in Table 21. Based on these results the Greece – Bulgaria CBA in terms of population distribution in FUAs appear a polycentric area with relatively mild slope of the regression line. The CBA appears slightly more polycentric than Greece and Bulgaria, but more monocentric than other Greek NUTS1 areas as Voreia Ellada (GR1) and Kentriki Ellada (GR2). The primacy of the biggest city over the rest FUAs of the CBA (Sofia) is moderate and definitely lower than the corresponding primacy of Athens and Thessaloniki over the rest FUAs of Greece and Voreia Ellada, respectively. However, the primacy of Sofia in the CBA territory appears higher than the corresponding primacy of Sofia in Bulgaria, of Athens in Kentriki Ellada and of Irakleion in N. Aigaiou – Kriti.

In terms of the GDP distribution in FUAs, the Greece – Bulgaria CBA shows a moderate polycentric economic development, but with higher slope than the respective NUTS0 and NUTS1 unit levels. The economic primacy of the city with the highest GDP (Sofia) is very low, significantly lower than the corresponding primacy of the more economically active FUAs in Greece, Bulgaria and the NUTS1 unit levels of Greece.

3.7. Location Index

This index examines the distribution of cities over the territory, by sub-dividing the territory into service areas in a manner that each point of the territory is allocated to the nearest centre. This method utilises the Thiessen polygons to define individual areas of influence around each of a set of points. In this way the area served by each centre can be measured. Such area of influence represents the PUSH (Potential Urban Strategic Horizon) areas, including all municipalities of which at least 10% of the area can be reached within 45 minutes from each FUA centre by car.

As a measure of the inequality of the size of service areas the Gini coefficient of inequality was used. The Gini coefficient measures the degree of inequality of a distribution between zero and one (or zero and 100), where zero indicates perfect equality and one (or 100) maximum polarisation. Table 22 presents the PUSH areas of the Greece – Bulgaria CBA, their status, their number of municipalities included in the full area, the 50%, 10% and 5% of PUSH areas. Tables 23 and 24 illustrate the PUSH areas location polycentricity and settlement characteristics.

Table 22. PUSH areas of the Greece – Bulgaria CBA.

Name	NUTS3 - ID	FUA-ID	PUSH-ID	Full Area	50%	10%	5%
SOFIA	BG411	BG10067	343	0	5	14	18
BLAGOEVGRAD	BG413	BG10043	327	0	5	9	13
PETRICH	BG413	BG10059	95	1	6	14	16
PERNIK	BG414	BG10058	336	0	3	12	14
KYUSTENDIL	BG415	BG10054	332	0	1	7	9
PLOVDIV	BG421	BG10061	338	2	12	20	26
ASENOVGRAD	BG421	BG10042	1332	1	7	19	21
HASKOVO	BG422	BG10050	1054	0	5	10	12
DIMITROVGRAD	BG422	BG10045	329	1	5	12	16
PAZARDZHIK	BG423	BG10057	335	3	8	20	23
KARDZHALI	BG425	BG10051	333	0	4	11	16
ALEXANDROUPOLIS	GR111	GR10585	647	1	7	10	12
XANTHI	GR112	GR10606	833	7	17	23	25
KOMOTINI	GR113	GR10595	834	5	14	17	19
DRAMA	GR114	GR10587	832	7	15	24	27
KAVALLA	GR115	GR10592	645	8	18	24	26
ORESTIAS	GR111		1150	2	6	9	9

where Full Area: the number of municipalities assigned to the PUSH area using the 100% criterion; 50%: the number of municipalities assigned to the PUSH area using the 50% criterion; 10%: the number of municipalities assigned to the PUSH area using the 10% criterion; and 5%: the number of municipalities assigned to the PUSH area using the 100% criterion.

Table 23. PUSH areas of the Greece – Bulgaria CBA, their population, FUAs centres, settlement area and Gini coefficient.

Name	NUTS3 - ID	FUA-ID	PUSH-ID	Population	FUAs Centres	Centres %	Settlement Area (km²)	Settlement %	Gini Coefficient
SOFIA	BG411	BG10067	343	1,519,028	1	69	530.85	8	0.7234
BLAGOEVGRAD	BG413	BG10043	327	205,984	0	41	81.96	3	0.5624
PETRICH	BG413	BG10059	95	198,201	0	37	84.50	2	0.4085
PERNIK	BG414	BG10058	336	1,510,003	2	90	495.00	8	0.7370
KYUSTENDIL	BG415	BG10054	332	176,658	0	84	117.61	4	0.5184
PLOVDIV	BG421	BG10061	338	874,153	2	100	403.53	6	0.5168
ASENOVGRAD	BG421	BG10042	1332	876,792	3	96	379.80	6	0.5321
HASKOVO	BG422	BG10050	1054	370,284	2	100	217.74	5	0.4938
DIMITROVGRAD	BG422	BG10045	329	555,222	3	100	316.88	5	0.5043
PAZARDZHIK	BG423	BG10057	335	812,915	1	46	308.11	5	0.5738
KARDZHALI	BG425	BG10051	333	411,472	3	53	164.78	3	0.5144
ALEXANDROUPOLIS	GR111	GR10585	647	161,156	1	76	37.31	1	0.5099
XANTHI	GR112	GR10606	833	293,971	2	86	61.01	1	0.4657
KOMOTINI	GR113	GR10595	834	245,032	2	94	53.39	1	0.4508
DRAMA	GR114	GR10587	832	266,547	1	72	64.90	1	0.4615
KAVALLA	GR115	GR10592	645	317,644	2	96	72.24	2	0.4607
ORESTIAS	GR111		1150	102,109	0	14	49.34	1	0.4323
CBA Mean				498,140		79	195.83	4	0.5123

where population: the total PUSH population in 2001; FUAs Centres: the number of other FUA centroids located within the PUSH area; Centres (%): the percentage of PUSH territory overlaid by other PUSH territories; Settlement Area: the total settlement area within the PUSH area; Settlement (%): the percentage of settlement areas on total PUSH area.

Table 24. Settlement distance and structure of PUSH areas in the Greece – Bulgaria CBA.

Name	NUTS3 - ID	FUA-ID	PUSH-ID	Mean Distance (km)	Area Concentration Index	Structure
SOFIA	BG411	BG10067	343	38.9	13,832	3
BLAGOEVGRAD	BG413	BG10043	327	29.0	1,232	4
PETRICH	BG413	BG10059	95	31.9	879	4
PERNIK	BG414	BG10058	336	39.7	13,296	3
KYUSTENDIL	BG415	BG10054	332	23.7	1,511	4
PLOVDIV	BG421	BG10061	338	41.9	2,877	3
ASENOVGRAD	BG421	BG10042	1332	43.4	2,889	3
HASKOVO	BG422	BG10050	1054	38.2	1,365	4
DIMITROVGRAD	BG422	BG10045	329	43.3	2,340	4
PAZARDZHIK	BG423	BG10057	335	38.5	2,848	3
KARDZHALI	BG425	BG10051	333	43.2	1,830	4
ALEXANDROUPOLIS	GR111	GR10585	647	35.2	1,480	4
XANTHI	GR112	GR10606	833	40.2	1,238	4
KOMOTINI	GR113	GR10595	834	36.8	1,574	4
DRAMA	GR114	GR10587	832	33.0	1,015	4
KAVALLA	GR115	GR10592	645	36.6	1,014	4
ORESTIAS	GR111		1150	32.8	859	4

where mean distance: the average distance between all settlement units within the PUSH concerned (in km); Area Concentration Index: the standardised maximum area concentration index; and Structure: the settlement structure (1 =sprawl; 2 =sparsely populated/rural; 3 = monocentric; 4 = polycentric).

From Table 22 it occurs that Kavala, Drama and Xanthi are the PUSH areas with the higher number of municipalities assigned in them, using the full-area and the 50% criterion. When the 5% criterion is used, then Drama, Kavala and Plovdiv are the PUSH areas with the higher number of municipalities assigned in them. From Table 23 it occurs that the mean PUSH population in the Greece – Bulgaria CBA is 498,140 inhabitants. Sofia and Pernik are the biggest in terms of population PUSH areas. Orestias, Alexandroupolis and Kyustendil are the lower in population PUSH areas. PUSH territories show a mean overlap of 79% with adjacent PUSH areas. The mean settlement area for each PUSH covers 195.83 km^2, with the highest settlement area in Sofia (495.00 km^2) and the lowest in Alexandroupolis (37.31 km^2). Settlements cover on average 4% of the PUSH areas in the CBA. A mean Gini Coefficient of 0.5123 reveals the moderate polarization in the distribution of settlements in the PUSH areas of the CBA. Increased polarization is shown in the PUSH area of Sofia (Gini = 0.7370).

However, as the Gini coefficient is applied on the settlement areas, it does not take into account the distance between or the relative location of the individual settlement units against each other. From Table 24 it occurs that the mean distance of settlements within the PUSH areas 32.8 km, with the highest distance (43.4 km) in Asenovgrad and the lowest in Kyustendil (23.7 km). The Area Concentration Index (ACI) was developed and applied, taking account of both the size of the settlement areas and their relative location against each other. The highest ACI was calculated in Sofia and the lowest in Orestias, Kavala and Drama.

Based on the information derived by ACI and the proportion of the settlement areas in the PUSH area, we may conclude the following on location polycentricity:

1. If there is a high maximum concentration index and a high proportion of settlement areas on the total PUSH area, the settlement structure can be considered as *sprawl*;
2. If there is a small maximum concentration index the settlement structure can be considered as *rural*;
3. If there is a medium to high maximum concentration index, and if the ratio of the areas of the greatest and second greatest settlement unit is below 0.5 (i.e. the size of the second greatest settlement unit is less than one half of the size of the greatest settlement unit, so the greatest one is dominating), the settlement structure can be considered as *monocentric*;
4. If there is a medium to high maximum concentration index, and if the ratio of the areas of the greatest and second greatest settlement unit is greater than 0.5 (i.e. the size of the second greatest settlement unit is more than one half of the size of the greatest settlement unit, so that at

least two centres can be identified within the PUSH), the settlement structure can be considered as *polycentric*.

Based on the above classification, it occurs that most PUSH areas of the Greece – Bulgaria CBA are considered as polycentric (structure 4), while only a limited number of areas are considered as monocentric (structure 3; Sofia, Pernik, Plovdiv, Asenovgrad and Pazardzhik) (Table 24).

Figure 25 illustrates the relation between Gini coefficients and the proportion of settlements in the PUSH areas. A tendency can be observed indicating that the higher the proportion of settlement areas on the PUSHs is, the higher are also the Gini coefficients. It is also shown that the greater the total settlement area within a PUSH is (which is represented by the radii of the circles), the higher is also their proportion on the total PUSH area.

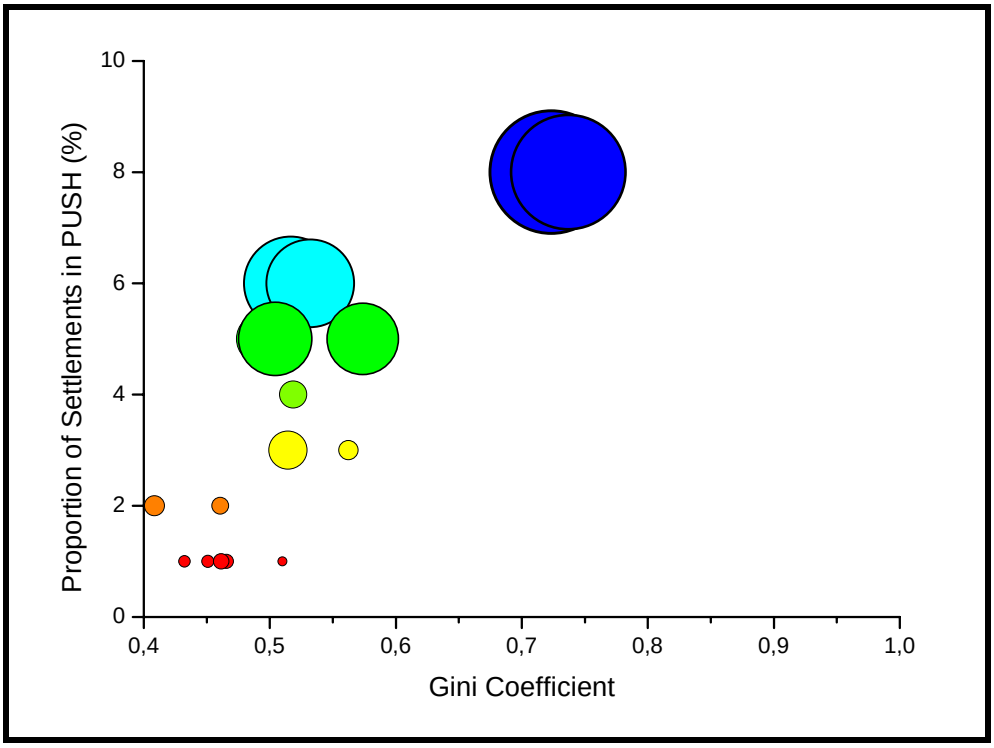

Figure 25. Gini coefficients and proportion of settlement area of total PUSH areas of the Greece – Bulgaria CBA. Circles radii represent the total settlement area within the PUSH.

A regression between Gini Coefficient and the mean distances between settlements within PUSHs is shown in Figure 26. It occurs that as Gini Coefficient increases, the mean distance between settlements increases. Similarly, as the Gini Coefficient increases, the maximum area concentration index also increases (Figure 27).

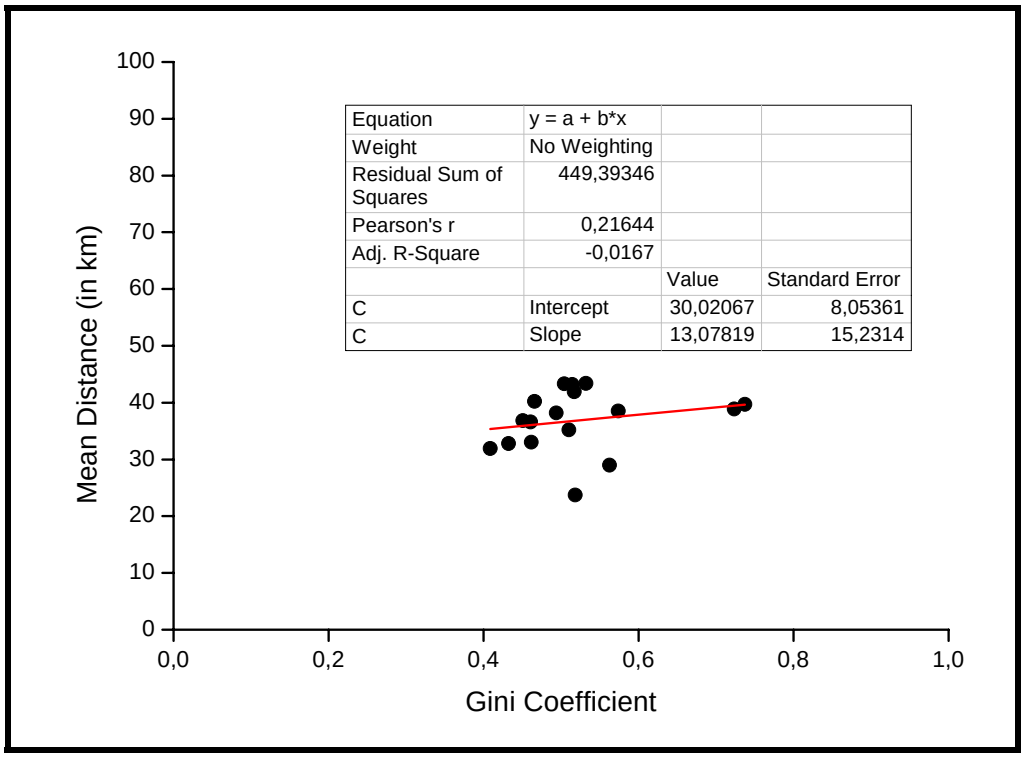

Figure 26. Gini Coefficients correlated to mean distances between settlements within PUSH areas.

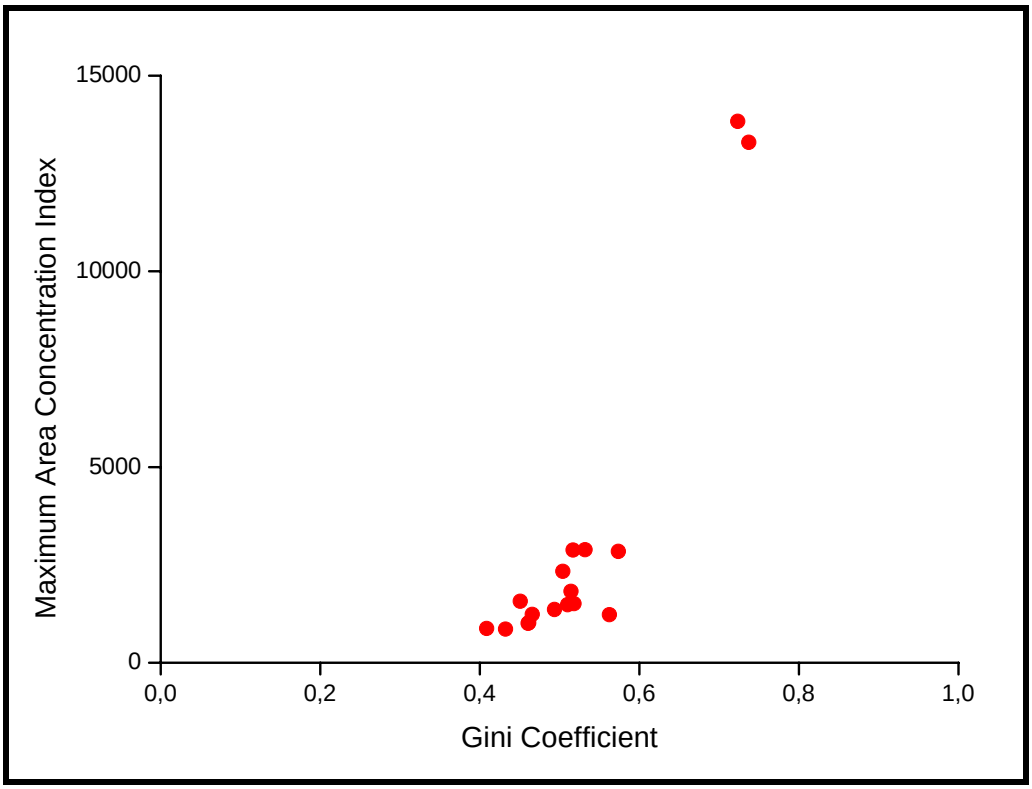

Figure 27. Relationship between the Gini Coefficients and the maximum Area Concentration Index for the PUSH areas of the Greece – Bulgaria CBA.

3.8. Connectivity Index

The connectivity of the FUAs constitutes one of the central factors of polycentrism. Connectivity may be determined by two ways: a) to measure the actual interactions, i.e., the functional relationships between cities, and b) to measure the potential for interactions.

Based on ESPON 1.1.1 it occurs that in a polycentric system, both small and large FUAs have good accessibility. The more accessible lower-level centres are compared to the primary city, the less monocentric is the urban system. To measure the actual interactions, accessibility was considered by the area covered by the 45-minutes isochrones, i.e., the area that can be reached from the respective FUA centre in 45 minutes, travelling by car with a mean travel speed. As the travel time calculation should be based on an unloaded network, i.e. no traffic flows should be taken into account it is assumed that a driving time threshold of 45 minutes translates into a real world driving time of 60 to 90 minutes, which in many countries is equivalent to the average commuting time. Based on the hypothesis that commuting mainly occurs within a 45-minute travel to work, this area could be considered as a potential commuter catchment area. Isochrone areas have been approximated to municipal boundaries, taking into account all municipalities of which at least 10% of the area can be reached within 45 minutes from each FUA.

The isochrones are overlaid with the municipality boundaries, and if they overlay to a certain degree, then the municipality is considered part of the Potential Urban Strategic Horizon (PUSH). At this stage, four different thresholds (scenarios) are applied in order to see how sensitive this assignment procedure is. According to these scenarios, municipalities are assigned to a PUSH, if the respective isochrones

(1) covered 100 % of the municipality territory (the full municipality area was overlapped) (scenario 1),

(2) covered at least 50 % of the municipality territory (i.e. more than half the NUTS 5 area was overlapped) (scenario 2),

(3) covered at least 10 % of the municipality territory (scenario 3), and finally

(4) covered at least 5 % of the municipality territory (scenario 4).

Speed limits for 45-minute isochrones are shown in Table 25. The area covered by the 45-minute isochrones, under the above scenarios, is presented in Table 26.

Table 25. Speed limits in Greek and Bulgarian road network.

Country	Inner-urban	Major roads outside towns	Expressways	Motorways
Bulgaria	60	90	90	120
Greece	50	90	90	120

Table 26. Area (in km^2) covered by the 45-min isochrones for the FUAs of the Greece – Bulgaria CBA.

Name	NUTS3 - ID	FUA-ID	Full - Area	50%	10%	5%
SOFIA	BG411	BG10067	0	2710	6746	8838
BLAGOEVGRAD	BG413	BG10043	0	1809	2937	4687
PETRICH	BG413	BG10059	43	1282	3876	4761
PERNIK	BG414	BG10058	0	2426	5930	6177
KYUSTENDIL	BG415	BG10054	0	958	2828	3612
PLOVDIV	BG421	BG10061	136	3956	6943	9227
ASENOVGRAD	BG421	BG10042	73	1910	6661	7320
HASKOVO	BG422	BG10050	0	2358	4628	5284
DIMITROVGRAD	BG422	BG10045	569	2288	6040	7670
PAZARDZHIK	BG423	BG10057	271	1863	6249	7313
KARDZHALI	BG425	BG10051	0	1681	5347	7044
ALEXANDROUPOLIS	GR111	GR10585	642	2259	3345	3609
XANTHI	GR112	GR10606	1097	3124	4383	5415
KOMOTINI	GR113	GR10595	737	2765	3870	4361
DRAMA	GR114	GR10587	826	2341	5923	6363
KAVALA	GR115	GR10592	1009	2587	4476	4985
ORESTIAS	GR111		426	1526	3344	3344

To measure the potential interactions in regards to connectivity, ESPON 1.1.1 expresses polycentric spatial development in terms of the potential accessibility of cities. For its measurement, the study uses the method followed by Shürmann et al (1997) for the SASI model, in which population is used as an activity function, and travel time as an impedance function. The formula used is, therefore, the following:

$$Accesibility = \sum_s W_s^a \exp(-bc_{rs}) \qquad (10)$$

where Accessibility is the potential accessibility of city r, W is the population of city s in the internal urban network considered, c_{rs} is the travel time between city r and s, measured in minutes. Parameters $\alpha = 1$ and $b = 10^{-2}$.

Using Equation (10) the accessibility values for all FUAs of the Greece – Bulgaria CBA were computed. Results are shown in Table 27.

Table 27. Accessibility values for the FUAs of the Greece – Bulgaria CBA.

Name	NUTS3 - ID	FUA-ID	Accessibility
SOFIA	BG411	BG10067	7,816,668
BLAGOEVGRAD	BG413	BG10043	1,083,394
PETRICH	BG413	BG10059	1,184,939
PERNIK	BG414	BG10058	1,222,732
KYUSTENDIL	BG415	BG10054	818,318
PLOVDIV	BG421	BG10061	3,147,833
ASENOVGRAD	BG421	BG10042	999,155
HASKOVO	BG422	BG10050	1,204,836
DIMITROVGRAD	BG422	BG10045	1,464,360
PAZARDZHIK	BG423	BG10057	887,625
KARDZHALI	BG425	BG10051	698,073
ALEXANDROUPOLIS	GR111	GR10585	1,011,493
XANTHI	GR112	GR10606	998,234
KOMOTINI	GR113	GR10595	1,100,568
DRAMA	GR114	GR10587	964,484
KAVALA	GR115	GR10592	746,354
ORESTIAS	GR111		635,821

Figure 26 presents the correlation between FUAs population and their accessibility throughout the Greece – Bulgaria CBA. The diagram depicts that larger cities show higher accessibility. Indeed, Sofia and Plovdiv are the FUAs with the higher accessibility of the CBA, while Orestias with the lower. The slope of the regression line (which appears as a curve in the diagrams due to the logarithmic transformation in the horizontal axis) is extremely low (slope = 0.15), suggesting that most FUAs depict a relative low change in accessibility as a result of population change. The primacy rate was computed to 4.16, indicating a relatively low degree of primacy of Sofia, in terms of accessibility, over the remaining CBA. Further, the Gini coefficient of accessibility, expressing the inequality in the distribution of this parameter across the Greece – Bulgaria CBA, was calculated as

0.39. This indicates a slight homogeneous distribution of the accessibility values throughout the Greece – Bulgaria CBA.

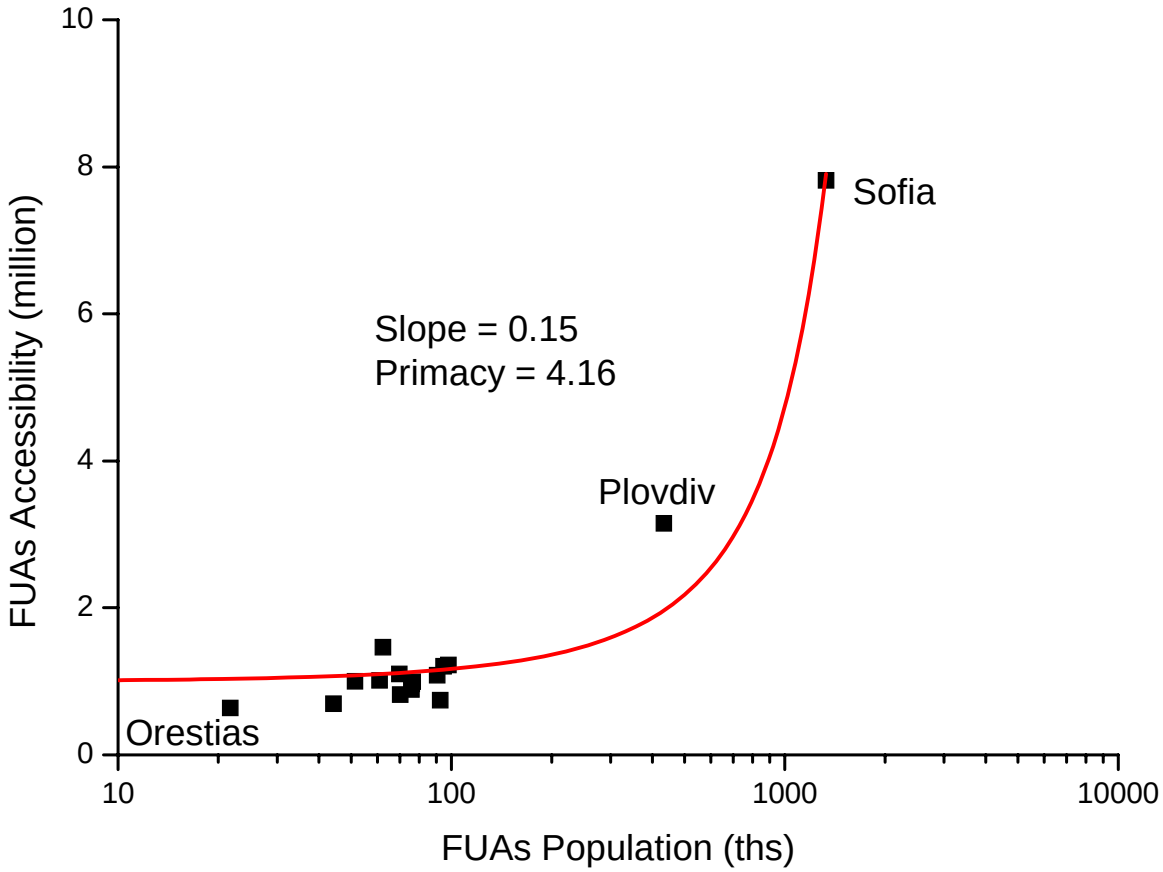

Figure 26. Population and accessibility of the FUAs in the Greece – Bulgaria CBA.

3.9. Polycentricity Index

Using the above determined partial polycentricity indices, namely the Size Index, the Location Index and the Connectivity Index, a combined Polycentricity Index can be derived.

Following the methodology proposed in ESPON 1.1.1, the seven sub-indicators were converted to utility scores using z-shaped value functions. This means that for each sub-indicator two threshold levels were defined, the indicator value at which polycentricity is 0, and the indicator value at which polycentricity is 100. Between the two threshold values linear interpolation was performed. Indicator values outside the range defined by the two threshold levels are 0 or 100, respectively.

Table 28 illustrates the threshold values defined for each of the seven sub-indicators.

Table 28. Lowest and highest threshold values for the seven sub-indicators.

	Rank-size distribution of population		Rank-size distribution of GDP		Size of Service Areas	Population and Accessibility	
	Slope (a)	Primacy (b)	Slope (c)	Primacy (d)	Gini (e)	Slope (f)	Gini (g)
Indicator Value for Polycentricity Index = 0	-1.75	7.50	-1.75	10.0	1.0	75.0	1.0
Indicator Value for Polycentricity Index = 100	-0.50	0.00	-0.50	0.00	0.0	0.0	0.0

After the transformation of sub-indicators, the utility scores are aggregated to derive the Polycentricity Index. Aggregation utilized relative weights (in percent), defined as:

A. Size Index (33%)

A.1. Population (50%)

- Slope of regression line (20%).
- Primacy rate (80%).

A.2. GDP (50%)

- Slope of regression line (20%)
- Primacy rate (80%)

B. Location Index (33%)

Gini coefficient of size of service areas

C. Connectivity Index (33%)

Correlation of population and accessibility

- Slope of regression line (50%)
- Gini coefficient of accessibility (50%)

Summarizing the above produced results for each sub-indicator, it occurs that the slope of the regression line for population rank-size distribution was -0.75, the population primacy rate was found as 3.66, the slope of the regression line for the GDP rank-size distribution was -1.47, the GDP primacy rate was 0.20, the Gini coefficient for the FUAs service areas was 0.48, the slope of the regression line for the population and accessibility relation was 0.15 and the Gini coefficient for accessibility values was found at 0.39.

Table 29 summarizes the results of the above analysis illustrating the component indices and the Polycentricity Index of the CBA, after the aggregation procedure.

Table 29. Component Indices and Polycentricity Index for the Greece – Bulgaria CBA and the NUTS0 and NUTS1 areas.

NUTS Area	FUAs No.	Size Index	Location Index	Connectivity Index	Polycentricity Index
Greece	45	36.6	95.9	73.6	63.4
Voreia Ellada (GR1)	20	39.3	93.8	54.5	58.3
Kentriki Ellada (GR2)	16	84.0	70.8	79.1	77.4
N. Aigaiou – Kriti (GR4)	8	81.7	99.9	77.7	85.5
Bulgaria	31	77.1	80.2	52.6	68.5
Greece – Bulgaria CBA	15	69.9	51.7	80.4	66.7

It occurs that the Size Index Value of the CBA is significantly higher than the corresponding value for Greece and slightly lower than that of Bulgaria. The CBA obtained the lower Location Index probably due to the inequality in the FUAs service areas. Connectivity Index was found at very high levels, significantly elevated than Bulgaria, Greece and the Greek NUTS1 examined areas. Finally, the combined Polycentricity Index shows relatively increased level, at quite similar level with the examined NUTS0 and NUTS1 areas.

3.10. Chapter Conclusions

- Polycentricity analysis was performed on Functional Urban Areas dataset of population and GDP, aiming to obtain the CBA's population and GDP primacy rates. Analysis of location, accessibility and connectivity indices of each FUA was also taken place. An aggregated polycentricity index was derived based on the weighted values of the above indices.
- Sixteen Functional Urban Areas (FUAs) exist in the Greece – Bulgaria CBA, with Sofia (stolitsa) being the main urban center of the CBA.
- Population primacy rate of the CBA was calculated at 3.35 in 2001 and at 3.66 in 2006, implying that population primacy of Sofia FUA in relation to the rest of the FUAs of the CBA gradually increases over time. This finding suggests that although the system is rather polycentric, it moves slowly towards a more monocentric pattern over time.

- GDP primacy rate of the CBA was found at 0.20 in 2006, meaning that Sofia excels a rather weak economic primacy over the rest of the FUAs of the Greece – Bulgaria CBA. This suggests a more balanced economic growth distribution of FUAs over the CBA.
- Location Index analysis revealed that the settlement structure in the Greece – Bulgaria CBA is considered as polycentric for most PUSH areas, while only Sofia, Pernik, Plovdiv, Asenovgrad and Pazardzhik are considered as monocentric.
- Accessibility Index analysis illustrates that Sofia and Plovdiv are the FUAs with the higher accessibility of the CBA, while Orestias with the lower. Most FUAs in the CBA depict a relative low change in accessibility over time, attributed to the limited FUAs population change. Accessibility primacy rate of Sofia was computed at 4.16, indicating a relatively low degree of primacy over the remaining CBA. Similarly, the Gini coefficient of accessibility indicates a rather homogeneous distribution of accessibility throughout the Greece – Bulgaria CBA.
- The combined Polycentricity Index (based on the aggregation of size, location and connectivity indices) shows relatively increased level, at quite similar level with the examined NUTS0 and NUTS1 areas.

Chapter 4 – Urban – Rural Relationships

4.1. Aims, Indicators and Methods

ESPON Project 1.1.2 defined the 'urban' and 'rural' space in Europe, examined their structural and functional inter-relationships and analysed the EU policies affecting these relations. With regard to the definition of a rural area in the EU, it is a territorial unit that has "a) population density up to 100 persons per km^2 , or share of agriculture equal or twice higher that the Community average for any year after 1985; b) average unemployment for the last three years higher than the community average, or a reduction of population after 1985". The main outcome of the project was the elaboration of a typology, based on a set of indicators, to identify the character of ESPON space NUTS3 regions, following a successive grading from urban to rural. Therefore, the main scope of this chapter is to characterise the Greece – Bulgaria cross-border area, according to the degree of urban influence and the degree of human intervention, and to identify the interrelation patterns between urban centres and their rural hinterlands.

The elaborated typology produced by ESPON 1.1.2 is based on the idea of two main dimensions, that is, the *degree of urban influence* on the one hand, and the *degree of human intervention* on the other hand. Urban influence is here defined according to population density and status of the leading urban centre of each NUTS3 area. Land cover is supposed to reflect both the degree of human intervention and actual land use. Degree of human intervention was determined by the relative share of land cover according to the main land cover classes of the CORINE data set. The main classes are artificial surfaces, agricultural areas, and residual land cover. The European average of artificial land cover is 3.48% of the total land cover. The corresponding figure of agricultural land is 50.36% and of the residual group it is 46.16%. The different land cover types were transformed into relative shares on the territorial scale of NUTS3.

In determining degree of *urban influence*, two factors were taken into account: population density and status of the leading urban centre of the region. Only two classes were defined, i.e. *high urban influence*, which included all NUTS3 areas with a population density more than the European average (107 persons per square km) and/or the areas where the leading urban centre of the NUTS3 area has been labelled "Metropolitan European Growth Area (MEGA). The rest of the NUTS3 regions were classified as being under *low urban influence*.

High human intervention corresponds to a situation where the share of artificial surfaces (and possibly one of the two other land cover categories) is above European average (i.e., 3.48%). *Medium human intervention* equals the cases where the share

of agricultural land (and possibly the share of residual land cover) is above European average (i.e., 50.36%). *Low human intervention* concerns all cases where only the share of residual land cover is above European average (i.e., 46.16%).

The two classes of *urban influence* and the three classes of *human intervention* were combined into a six-type model where the main division is in two classes of urban influence, that is, high and low, and a three-class subdivision into high, medium and low human intervention of the two main classes. The two-class main division indicates *functional* (status of urban centre equalising functional specialisation, population density equalling size of markets) as well as *structural* properties (population density equalling built up areas) and the three-class subdivision is based of the structural properties of the physical environment (relative share of the various kinds of the land cover) as well as function properties (land use).

The application of the above defined model on the ESPON space, showed that the regional type 1 (high urban influence, high human intervention) covers only 19% of the total area, but houses 60% of the population and produces 72% of the total GDP. Results revealed that nearly four fifths of the GDP of Europe is produced in slightly more than one fourth of the territory that is under high urban influence. On the contrary, the regional types of low urban influence and medium or low human intervention, count for 53% of the total territory, but account only 20% of the total population and produce only 16% of the total GDP.

The basic indicators for the analysis of urban – rural relations for the Greece – Bulgaria CBA, involve:

- The population density;
- The urban – rural population proportion;
- The employment and the produced GVA by sector/NACE (% of employed in agriculture, forestry and fishing), and
- Land use (% artificial area; % agricultural area; % forest area).

Based on national definitions on 'urban' and 'rural' areas, it was considered useful to give a first picture of the overall situation in the Greece – Bulgaria CBA.

Bulgaria adopted through the project for the National Rural Development Plan (2007 – 2013) a different definition than EU for rural areas. These would be "the municipalities where, on one hand, the largest town has a population of less than 50,000 inhabitants and population density is up to 150 inh per sq.km and, on the other, the share of agricultural employment is above the country average". The national resorts are excluded from the rural areas.

In Greece, rural areas are the municipalities in which the largest settlement has less than 2,000 inhabitants, while in urban areas the largest population centre has 2,000 or more inhabitants (National Statistical Service of Greece 2004). Up to the 1991 Census there was also the distinction between urban areas (10,000 inhabitants and more) and semi-urban areas (2,000-10,000 inhabitants). In the

2001 Census, the category of semi-urban areas was incorporated into the one of the urban areas, so that the only distinction is currently between urban and rural areas.

OECD defines rural areas in terms of population density (150 inh/sq.km). According to this definition rural areas in Greece should include the former semi-urban Greek regions and in that case it is estimated that 95% of the Greek territory is rural (Hellenic Ministry for the Environment, Physical Planning and Public Works 1998).

4.2. Population Density

Population density was taken as an indicator of the degree of urban influence. The higher population density, the higher the urban influence was supposed to be.

The mean population density of the CBA for the year 2008 was calculated as 111.4 inhabitants per sq km, significantly higher than the mean value of Bulgaria (68.7 inhabitants per sq km) and Greece (85.9 inhabitants per sq km). CBA's population density appeared slightly lower than the mean EU27 corresponding value (116.0 inhabitants per sq km) and significantly higher than the corresponding value for EU10+2 (97.0 inhabitants per sq km). Table 30 presents the evolution of population density for the period 1999 – 2008 for the NUTS 0, 1, 2 and 3 level units of the Greece – Bulgaria CBA.

It occurs that in most NUTS3 regions of the Greece – Bulgaria CBA, population density depicts a decreasing trend. Table 31 presents the linear regression models and the linear projections of population density for year 2020. According these models, it occurs that in year 2020 most NUTS3 level units are expected to be characterised as 'strongly rural areas' (having population density below 50 inh per sq.km). Such NUTS areas are Sofia (BG412), Blagoevgrad (BG413), Pernik (BG414), Kyustendil (BG414), Haskovo (BG422), Smolyan (BG424), Kardzhali (BG425) and Drama (GR114). These 'strongly rural areas' depict strong depopulation expressed by the decreasing population density trend. 'Moderately rural areas', having population density higher than 50 inh per sq. km but lower than EU average, are characterised NUTS3 areas as Pazardzhik (BG423), Xanthi (GR112) and Kavala (GR115). Apart of Xanthi (GR112) the other two areas show slight decreasing population density trend. Similar behaviour is shown by the NUTS2 area of Yuzhen tsentralen (BG42) and the national population density trends of Bulgaria and Greece. As expected, Sofia stolitsa (BG411) was the only NUTS3 area of the CBA with an increasing population density trend, reaching up to 963 inh per sq.km in year 2020, and characterised as 'strongly urban area'. It is also the only MEGA category 4 city of the Greece – Bulgaria CBA. Plovdiv (BG421) shows a slight population density reduction with time, reaching a population density of 111.9 inh per sq.km in year 2020, approaching the EU average limit and being characterised as a 'moderately urban area'.

Table 30. Population density (inhabitants per sq km) of the NUTS0, 1, 2 and 3 unit levels of the Greece – Bulgaria CBA during the period 1999 – 2008.

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	Status of Urban Influence
Bulgaria	74.0	73.6	71.3	70.9	70.5	70.1	69.7	69.4	69.0	68.7	Low
Yugozapaden	105.7	105.6	103.3	103.6	103.8	104.0	104.2	104.3	104.2	104.1	Low
Sofia (stolitsa)	896.6	905.1	870.5	880.6	890.8	900.8	909.2	915.4	918.8	922.2	High
Sofia	37.5	36.7	38.4	38.2	37.7	37.3	37.0	36.7	36.5	36.2	Low
Blagoevgrad	54.0	53.4	52.8	52.4	52.1	52.0	51.8	51.4	51.1	51.0	Low
Pernik	64.5	63.8	62.2	61.6	60.7	59.8	59.1	58.6	58.2	57.7	Low
Kyustendil	56.1	55.6	53.0	52.4	51.6	50.9	50.3	49.7	49.2	48.6	Low
Yuzhen tsentralen	75.5	75.2	71.8	71.3	70.9	70.5	70.0	69.6	69.3	68.9	Low
Plovdiv	122.3	122.2	119.8	119.5	119.2	118.9	118.7	118.4	118.2	118.0	High
Haskovo	53.1	52.5	50.0	49.5	49.0	48.7	48.3	47.9	47.5	47.1	Low
Pazardzhik	71.0	70.5	69.5	68.9	68.3	67.7	67.1	66.6	66.2	65.8	Low
Smolyan	45.8	45.5	43.7	43.1	42.6	42.0	41.3	40.8	40.4	39.9	Low
Kardzhali	62.7	62.7	51.0	50.7	50.4	50.0	49.6	49.2	48.9	48.7	Low
Greece	83.3	83.5	83.8	84.1	84.3	84.6	84.9	85.2	85.6	85.9	Low
Anatoliki Makedonia, Thraki	43.0	43.2	43.2	43.2	43.2	43.2	43.3	43.2	43.2	43.1	Low
Evros	35.3	35.4	35.4	35.3	35.3	35.3	35.5	35.3	35.2	35.2	Low
Xanthi	58.0	58.4	58.7	58.9	59.2	59.6	59.9	60.2	60.5	60.8	Low
Rodopi	44.1	44.3	44.4	44.4	44.3	44.4	44.4	44.2	44.2	44.1	Low
Drama	29.3	29.4	29.5	29.4	29.3	29.2	29.1	29.1	29.0	28.9	Low
Kavala	67.4	67.6	67.5	67.4	67.3	67.2	67.2	67.1	66.9	66.8	Low
CBA Average	113.2	113.5	109.8	110.2	110.5	110.9	111.2	111.4	111.4	111.4	High

Table 31. Linear regression models for NUTS0, 2 and 3 level units of the Greece – Bulgaria CBA and year 2020 population density projections.

NUTS Regions	Linear Regression Model	R^2	2020 Projection for Population Density (inh per sq.km)	Urban – Rural Area Characterization
Bulgaria	-0.5661 t + 1204.8	0.89	61.3	Moderately Rural
Yugozapaden	Unreliable Linear Regression Model			
Sofia (stolitsa)	3.9188 t – 6950.3	0.50	965.7	Strongly Urban
Sofia	-0.1552 t + 348.1	0.41	34.6	Strongly Rural
Blagoevgrad	-0.3152 t + 683.6	0.95	46.9	Strongly Rural
Pernik	-0.7685 t + 1600.3	0.97	47.9	Strongly Rural
Kyustendil	-0.823 t + 1700.7	0.94	38.2	Strongly Rural
Yuzhen tsentralen	-0.703 t + 1479.8	0.84	59.7	Moderately Rural
Plovdiv	-0.463 t + 1047.2	0.82	111.9	Moderately Urban
Haskovo	-0.6267 t + 1304.9	0.88	39.0	Strongly Rural
Pazardzhik	-0.5903 t + 1250.8	0.99	58.4	Moderately Rural
Smolyan	-0.6624 t + 1369.7	0.97	31.7	Strongly Rural
Kardzhali	-1.4261 t + 2909.5	0.62	28.8	Strongly Rural
Greece	0.2897 t – 495.89	0.99	89.3	Moderately Rural
Anatoliki Makedonia, Thraki	Unreliable Linear Regression Model			
Evros	Unreliable Linear Regression Model			
Xanthi	0.3079 t – 557.42	0.99	64.5	Moderately Rural
Rodopi	Unreliable Linear Regression Model			
Drama	-0.057 t + 143.36	0.80	28.2	Strongly Rural
Kavala	-0.0788 t + 225.09	0.88	65.9	Moderately Rural
CBA Average	Unreliable Linear Regression Model			

4.3. Urban – Rural Population

Urban and rural population data were provided at NUTS3 level, by the Bulgarian Statistical Institute, for the period 2004-2009. Similarly, urban and rural population data at NUTS5 level for year 2001 were provided by the Hellenic Statistical Service. These data were aggregated to the NUTS3 level. Table 32 presents the temporal variation of urban population percent for each of the NUTS3, 2 and 0 level units of the Greece – Bulgaria CBA. Figure 27 illustrates the spatial distribution of urban and rural population and Figure 28 the relative percentages of urban-to-rural population.

It occurs that the level of urbanism for Bulgaria and Greece is relatively high and quite similar (71.41% and 72.79%, respectively). In terms of NUTS2 areas, Yugozapaden (BG41) shows the stronger urbanism proportion, with 82.35% of total population living in urban areas. This is mostly due to Sofia (stolitsa) (BG411) which dominates the region in urban population proportion (95.40%), followed by Pernik (BG414) with 76.04%. NUTS3 areas as Sofia (BG412) and Blagoevgrad (BG413) depict a relatively balanced level of urbanism, with proportions of 59.92% and 58.97%, respectively. Yuzhen Tsentralen (BG42) region shows significantly lower urban population proportion (66.46%), with Plovdiv (BG421) having the higher urban population percentage (74.45%) and Kardzhali (BG425) being a relatively rural area with urban population percentage of 41.79%.

Table 32. Urban population percentage of the NUTS0, 2 and 3 unit levels of the Greece – Bulgaria CBA during the period 2004 – 2009.

	2001	2004	2005	2006	2007	2008	2009
Bulgaria		69.99	70.17	70.65	70.72	71.08	71.41
Yugozapaden		81.40	81.56	81.90	81.98	82.22	82.35
Sofia (stolitsa)		95.38	95.38	95.36	95.37	95.39	95.40
Sofia		58.93	59.01	59.31	59.51	59.85	59.92
Blagoevgrad		57.42	57.57	58.43	58.55	58.77	58.97
Pernik		75.51	75.45	75.83	75.54	75.96	76.04
Kyustendil		66.41	66.54	67.02	66.99	67.50	67.87
Yuzhen tsentralen		65.09	65.26	65.91	65.97	66.28	66.46
Plovdiv		72.58	72.73	73.82	73.97	74.27	74.45
Haskovo		69.97	69.99	70.26	69.82	70.14	70.20
Pazardzhik		61.49	61.54	61.74	61.77	62.00	62.12
Smolyan		52.65	52.99	53.43	53.75	54.21	54.59
Kardzhali		40.76	41.07	41.28	41.38	41.66	41.79
Greece	72.79						
Anatoliki Makedonia, Thraki	59.11						
Evros	59.33						
Xanthi	57.83						
Rodopi	51.47						
Drama	63.08						
Kavala	62.77						

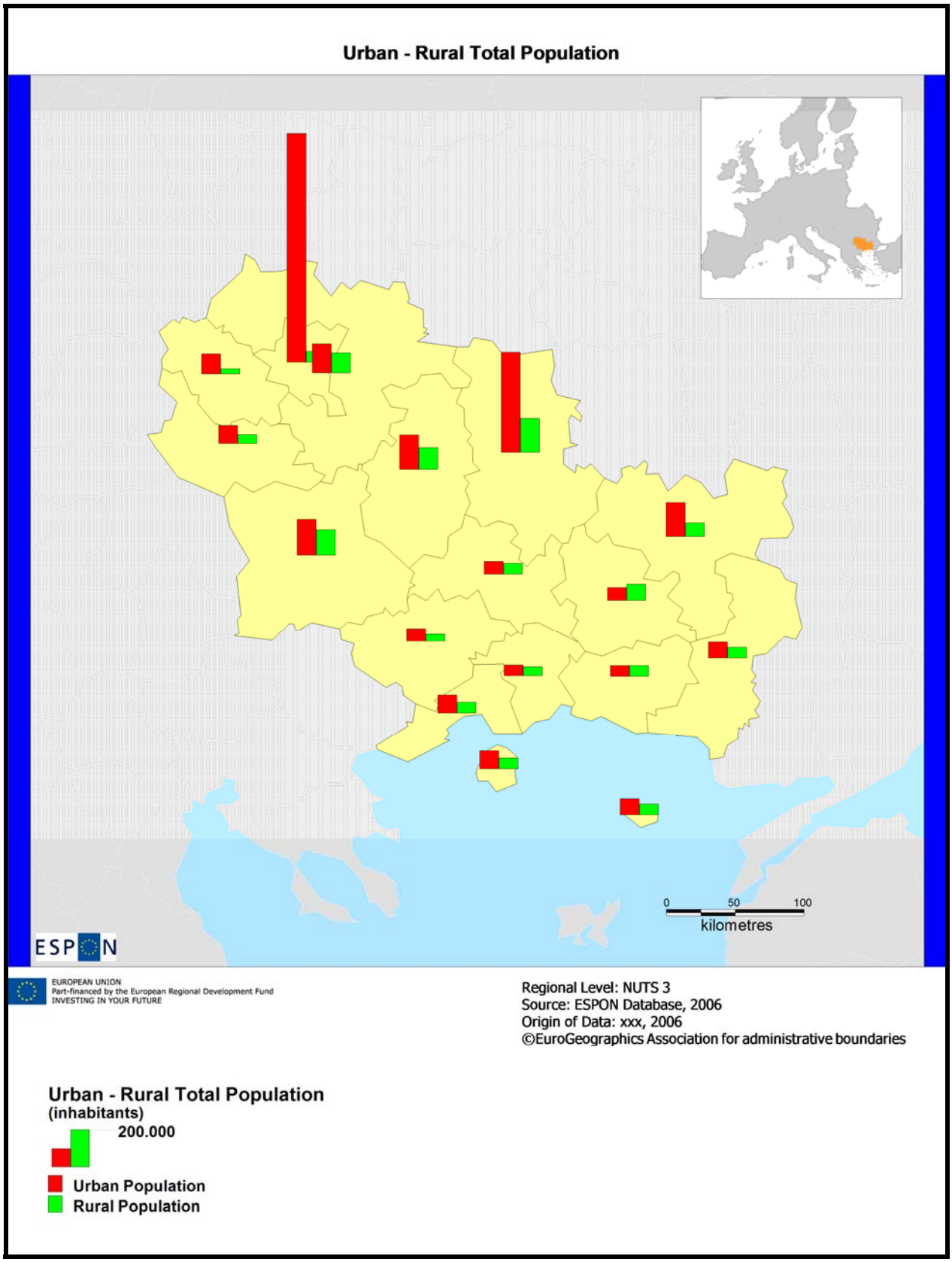

Figure 27. Distribution of urban and rural population of the NUTS3 areas of the Greece – Bulgaria CBA.

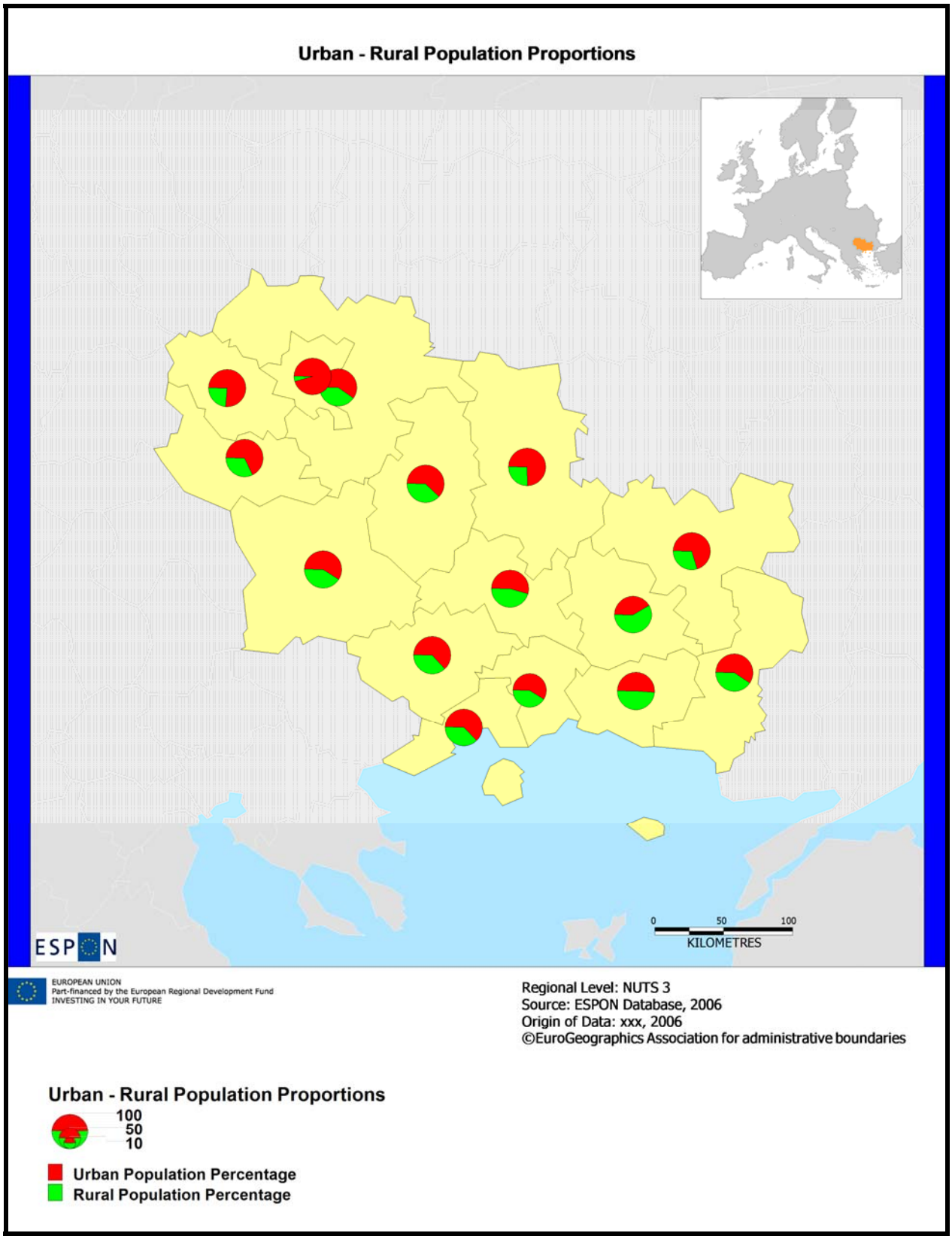

Figure 28. Urban-to-rural population proportions (%) at the NUTS3 areas of the Greece – Bulgaria CBA.

Finally, Anatoliki Makedonia, Thraki (GR11) is a NUTS3 region with almost balanced 'urban-to-rural' population (59.11%). Drama (GR114) and Kavala (GR115) present the higher urban population proportions (63.08% and 62.77%, respectively). Rodopi (GR113) appears as the most rural NUTS3 area of the region, having the 51.43% of its total population living in urban centres.

Examination of the temporal evolution of the urban population proportions for Bulgaria and the Bulgarian NUTS2 and 3 regions of the CBA, during the period 2004-2009, depicts a gradual increase of urbanism through time (Figure 29). Indeed, urban population proportion increases within the examined time span by 0.23% per year for Yugozapaden (BG41) and by 0.42% per year for Yuzhen Tsentralen (BG42). More importantly, areas with relatively low degree of urbanism depict higher annual urban population increase, as Blagoevgrad (BG413, 58.97%, 0.31% per year), in relation to strongly urban areas, as Sofia stolitsa (BG411, 95.40%, 0.00% per year). Similarly, in Yuzhen Tsentralen (BG42), Smolyan (BG424) with relatively balanced urban-rural population proportions, shows the higher annual percentage increase in urban population (0.39%). Overall, the annual urban population increase in both Bulgarian NUTS2 regions (BG411, 0.19% and BG42, 0.27%) is almost equal to the national annual increase (BG, 0.28%).

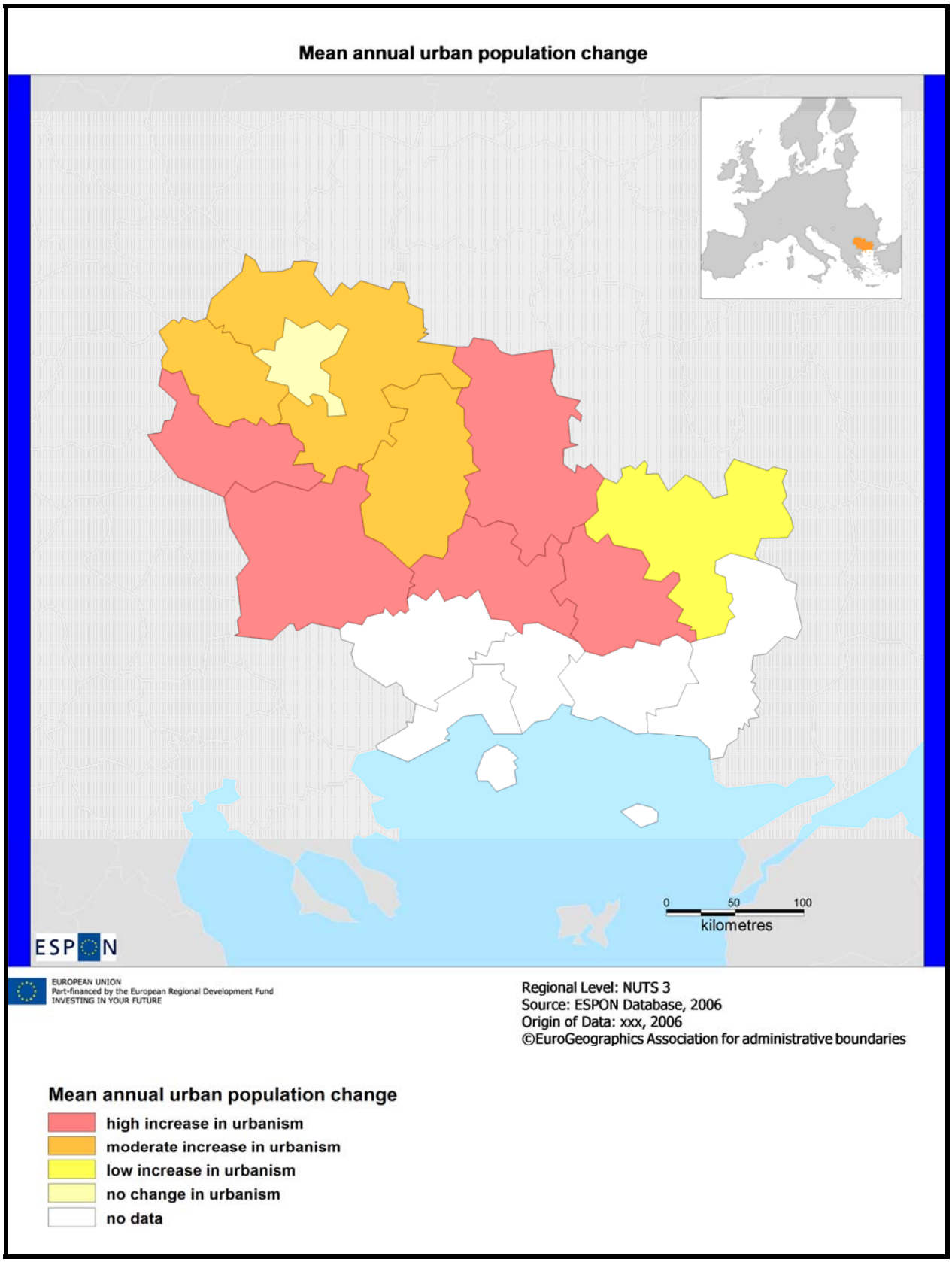

Figure 29. Mean annual urban population change of the NUTS3 areas in the Greece – Bulgaria CBA.

4.4. Employment and GVA from Agriculture, Forestry and Fishing

Data on employment in agriculture, forestry and fishing for the Greece – Bulgaria CBA exist only in NUTS0, 2 and 3 levels (Table 33). It occurs that 394.000 people were employed in the CBA in the agriculture, forestry and fishing sector, with a significant reducing trend for most NUTS3 level areas, during the 2000-08 period. Table 34 presents the employment in the primary sector in all NUTS0, 2 and 3 levels in 2000 and 2008 and the relative contribution of this sector in total employment. As shown, the Greece – Bulgaria CBA appears to be characterized by an increased 'level of ruralism', as approximately 15.85% of the economically active population are employed in the agriculture, forestry and fishing sector (Table 34). This increased participation in primary sector employment appears mostly attributed to the impact of Yuzhen Tsentralen (BG42), where almost 27% of the total economically active population is employed in this sector. In Anatoliki Makedonia, Thraki (GR11) this percentage reduces to approximately 25%, while in Yugozapaden (BG41) 'rurality' is diminished as only 7.6% are employed in this sector.

Comparing the above NUTS2 data for the Greece – Bulgaria CBA with the national corresponding values it occurs that in Bulgaria approximately 743,000 people, corresponding to 19.42% of total economically active population, are employed in the agriculture, forestry and fishing sector. The employment in primary production sector dataset for the 2000 – 2008 period shows a gradual reduction trend with an average decrease for Bulgaria of 0.74% per year. This 'rurality' reduction is higher for Yuzhen Tesentralen (-1.64%), with Pazardzhik (BG423) depicting the highest annual decreasing rate of -11.55%. An almost equal increase in the employment in agriculture, forestry and fishing is shown in Yugozapaden (+1.62%), mostly attributed to the positive trends observed in Blagoevgrad (BG413, +4.63%) and Sofia (BG412, +2.09%).

In Greece approximately 541,000 people are employed in this primary production sector, representing about 11.29% of total economically active population. The annual reduction of population employment in agriculture, forestry and fishing appears significantly raised for Greece, up to 3.55%. This trend is similar for Anatoliki Makedonia, Thraki (GR11). Indeed, in year 2000 approximately 33% of the economically active population was employed in this primary production sector in Anatoliki Makedonia, Thraki (GR11), decreasing rapidly to almost 25% in year 2008. As a result of the above, the Greece – Bulgaria CBA depicts an average annual employment in primary sector decrease of 1.21%.

Table 33. Employment in Agriculture, Forestry and Fishing in the NUTS0, 2 and 3 unit levels of the Greece – Bulgaria CBA for the period 2000 – 2008.

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bulgaria	788.8	775.4	771.6	765.5	759.5	748.4	738.6	729.4	743.0
Yugozapaden	86.2	113.2	92.8	98.9	96.8	97.7	95.3	97.9	98.0
Sofia (stolitsa)	15.8	25.1	29.1	34.9	24.9	33.8	33.2	23	18.3
Sofia	20.6	17.7	18.7	19.4	19.8	19.8	19.4	21.2	24.3
Blagoevgrad	25.7	20	18.6	22.7	24.3	21.5	20.9	40.4	36.9
Pernik	9.7	15.6	16.2	9.4	10.8	11.5	11.1	5.5	6.5
Kyustendil	14.4	34.8	10.2	12.5	17	11.1	10.7	7.8	12
Yuzhen tsentralen	225.7	182.1	168.9	172.2	155.1	160.3	157.8	180.5	197.8
Plovdiv	64.7	70.3	80.7	74.5	66.5	74.2	73	70.2	83.9
Haskovo	32.5	15	16	21.2	19.1	22.8	23.6	34.3	39.3
Pazardzhik	83.3	51.9	33.8	29	27.6	22.4	21.8	35.3	31.2
Smolyan	30.5	31.8	28.2	36.5	33.8	34.3	33.1	21.2	20.2
Kardzhali	14.7	13.1	10.2	11	8.1	6.6	6.3	19.5	23.2
Greece	722.4	670.8	659.8	642.8	570.4	567.2	558.2	541.8	541.2
Anatoliki Makedonia, Thraki	82.2	76.6	80	74.6	63.8	62.6	63.7	61.7	61.6
Evros	19.5	16.8	18.9	17.5	14.2	12	12.4	12.8	12.8
Xanthi	14	14	15.3	14.2	12.9	13	12.8	12.5	12.5
Rodopi	34.8	32.3	32.3	29.9	23.8	25.2	24.9	23.9	23.8
Drama	5.3	6.7	6.3	5.8	4.3	4	4.7	4.4	4.4
Kavala	8.6	6.8	7.2	7.2	8.6	8.4	8.9	8.1	8.1
CBA Total	394.1	371.9	341.7	345.7	315.7	320.6	316.8	340.1	357.4

Table 34. Employment share and annual growth of employment in Agriculture, Forestry and Fishing in the NUTS0, 2 and 3 unit levels of the Greece – Bulgaria CBA for the period 2000 – 2008.

NUTS Name	Code	Employment in Agriculture, Forestry and Fishing (thousands of persons)		Share of employment in Agriculture, Forestry and Fishing by total employed (%)		Annual growth rate of employment in Agriculture, Forestry and Fishing (2000-2008)
		2000	2008	2000	2008	
Bulgaria	BG	788.8	743.0	24.35	19.42	-0.74%
Yugozapaden	BG41	86.2	98.0	9.37	7.64	+1.62%
Sofia (stolitsa)	BG411	15.8	18.3	2.68	2.02	+1.85%
Sofia	BG412	20.6	24.3	22.39	24.01	+2.09%
Blagoevgrad	BG413	25.7	36.9	21.27	22.32	+4.63%
Pernik	BG414	9.7	6.5	18.55	13.98	-4.88%
Kyustendil	BG415	14.4	12.0	22.09	19.61	-2.25%
Yuzhen tsentralen	BG42	225.7	197.8	33.78	27.18	-1.64%
Plovdiv	BG421	64.7	83.9	23.30	23.46	+3.30%
Haskovo	BG422	32.5	39.3	30.98	32.72	+2.40%
Pazardzhik	BG423	83.3	31.2	53.47	26.90	-11.55%
Smolyan	BG424	30.5	20.2	40.78	28.73	-5.02%
Kardzhali	BG425	14.7	23.2	26.78	36.36	+5.87%
Greece	GR	722.4	541.2	16.98	11.29	-3.55%
Anatoliki Makedonia, Thraki	GR11	82.2	61.6	33.76	25.16	-3.54%
Evros	GR111	19.5	12.8	30.81	19.39	-5.13%
Xanthi	GR112	14.0	12.5	33.82	28.15	-1.41%
Rodopi	GR113	34.8	23.8	65.29	44.57	-4.64%
Drama	GR114	5.3	4.4	16.72	14.97	-2.30%
Kavala	GR115	8.6	8.1	15.99	15.58	-0.75%
CBA Total		394.1	357.4	21.52	15.85	-1.21%

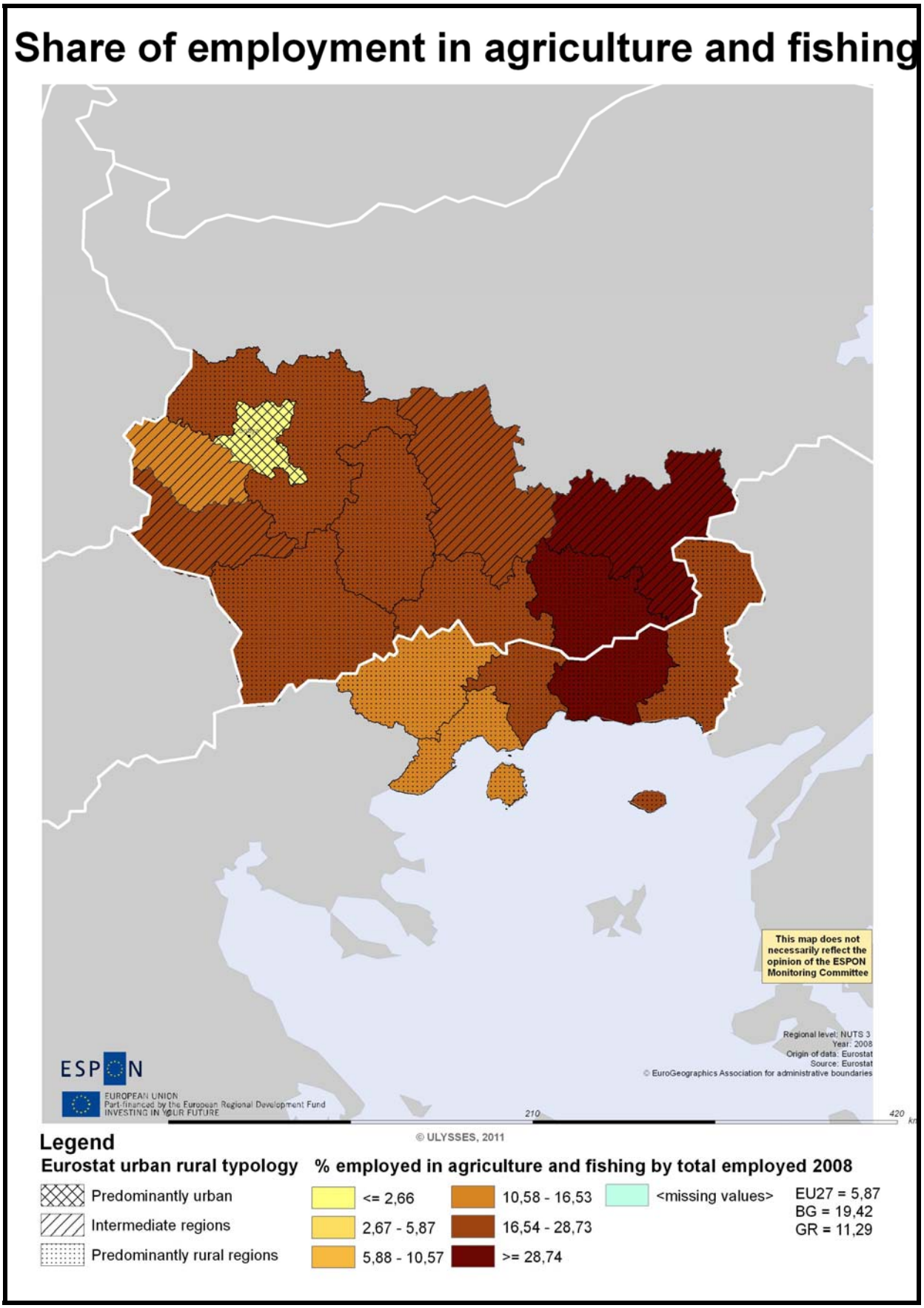

Figure 30. Percentage of employment in Agriculture, Forestry and Fishing related to the total economically active population, for year 2008.

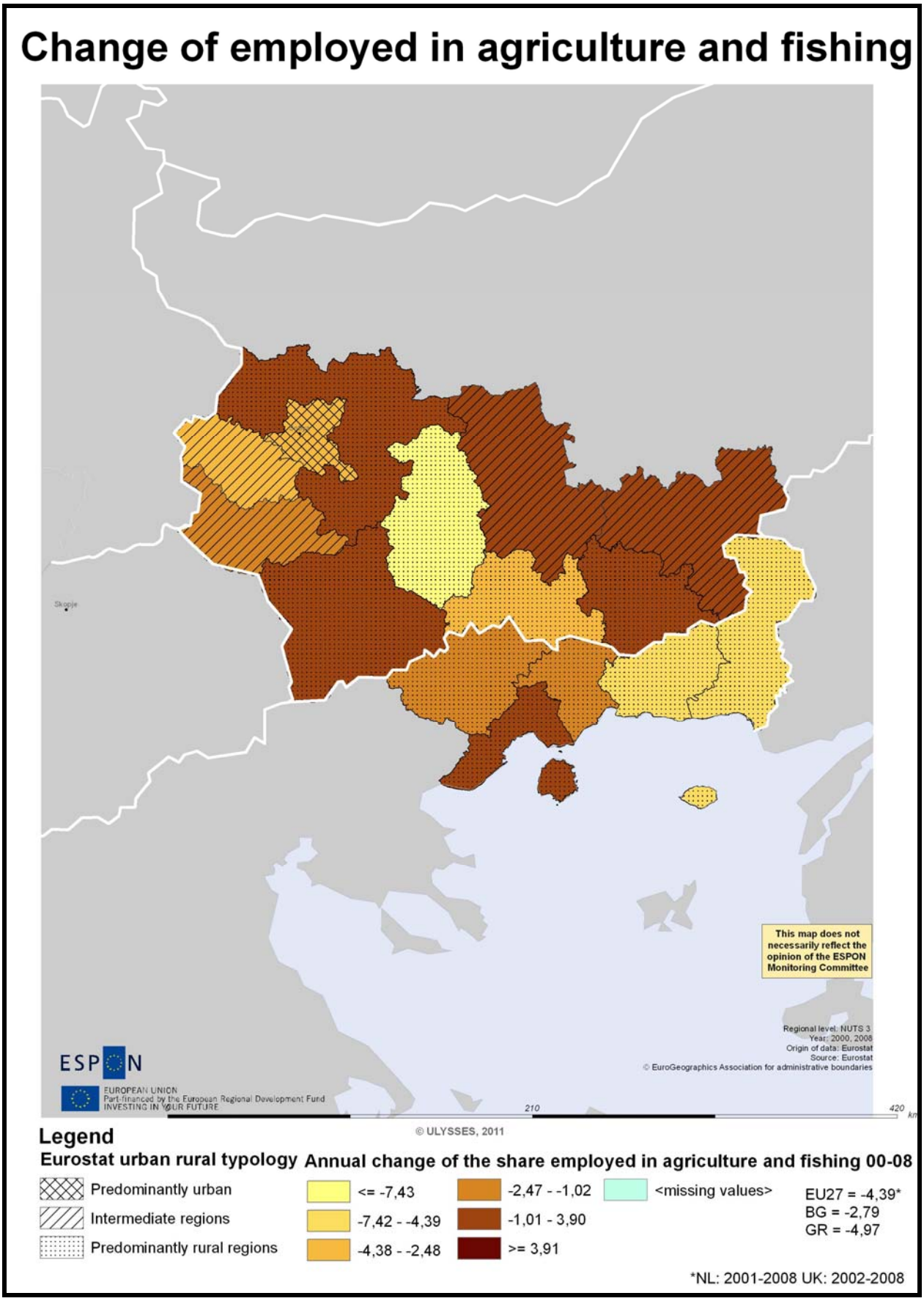

Figure 31. Annual change in the percentage of employment in Agriculture, Forestry and Fishing related to the total economically active population, for years 2000-2008.

Based on the above, and following Eurostat urban-rural typology, it occurs that Sofia-stolitsa (BG411) is the only 'predominantly urban area' of the CBA, Sofia (BG412), Blagoevgrad (BG413), Pazardzik (BG423), Smolyan (BG424) and Kardzhali (BG425) are considered as 'predominantly rural regions', together with the whole Anatoliki Makedonia, Thraki (GR11) area (Figure 30). All remaining NUTS3 areas of the CBA are considered as regions of intermediate 'rurality'. A cluster of regions containing Rodopi (GR113), Kardzhali (BG425) and Haskovo (BG422) show the highest share of people employed in Agriculture, Forestry and Fishing (>25% of totally employed population). Figure 31 shows the annual change in the share of employment in Agriculture, Forestry and Fishing. A cross-border cluster of NUTS3 regions occurs, consisting of Smolyan (BG424), Xanthi (GR112) and Drama (GR114), with employment reduction of less than 5%.

Moreover, the dataset of Gross Added Value (GVA, in million euros) produced in Agriculture, Forestry and Fishing is examined in NUTS0, 2 and 3 unit levels for the Greece – Bulgaria CBA, during the period 2000-2008 (Table 35). It occurs that in the Greece – Bulgaria CBA, approximately 1,315.2 million euros are produced in 2008 by the primary production sector. Of this sum, 24.0% (or 315.9 million euros) is produced in Yugozapaden (BG41), 37.9% (or 498.7 million euros) is produced in Yuzhen tsentralen (BG42) and 38.1% (500.6 million euros) is produced in Anatoliki Makedonia, Thraki (GR11). In terms of NUTS3 unit levels, Pernik (BG414), Sofia stolitsa (BG411) and Kyustendil (BG415) are producing the lower GVAs from agriculture, forestry and fishing (30.0, 35.1 and 43.5 million euros, respectively). The NUTS3 areas of Plovdiv (BG421), Blagoevgrad (BG413), Evros (GR111) and Kardzhali (BG425) are producing the higher GVAs of the Greece – Bulgaria CBA from agriculture, forestry and fishing, with values of 141.9, 135.0, 124.9, 113.8 million euros, respectively.

In terms of temporal variability in GVAs, it occurs that most Bulgarian NUTS2 and 3 areas depict an increasing tendency through time, while the corresponding Greek areas show an opposite effect, following well the national trend. Linear regression models for the NUTS0, 2 and 3 areas of the CBA, and the respective projections for year 2020 are presented in Table 36.

Figure 32 illustrates the percentage of GVA produced by Agriculture, Forestry and Fishing related to the total GVA of each NUTS3 region of the Greece – Bulgaria CBA, for the year 2008. All Bulgarian areas located closely to the Greece – Bulgaria borderline depict the higher percentages (>10%) in GVA production from primary sector activities. Figure 33 presents the annual change in GVA produced by Agriculture, Forestry and Fishing for each NUTS3 area of the Greece – Bulgaria CBA. A cluster of areas (Pazardzhik, BG423; Blagoevgrad, BG413; Smolyan, BG424; Drama, GR114 and Xanthi, GR112) show almost equal behaviour in their annual primary production sector GVA change (from -7 to -10%).

Table 35. Gross Value Added from Agriculture, Forestry and Fishing in the NUTS0, 2 and 3 unit levels of the Greece – Bulgaria CBA, during the period 2000 – 2008.

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bulgaria	1,665.5	1,782.2	1,790.2	1,788.9	1,860.9	1,785.0	1,707.0	1,547.5	2,040.2
Yugozapaden	218.0	215.9	205.6	275.4	280.2	272.8	262.5	255.8	315.9
Sofia (stolitsa)	24.0	28.6	30.8	26.7	29.7	24.9	26.3	25.6	35.1
Sofia	54.7	56.7	54.9	58.2	61.4	68.6	55.2	53.1	72.3
Blagoevgrad	63.9	63.5	55.2	97.7	104.1	103.9	101.5	101.0	135.0
Pernik	34.5	32.0	31.6	30.4	29.9	27.3	28.8	22.3	30.0
Kyustendil	40.8	35.1	33.0	62.5	55.1	48.2	50.8	53.7	43.5
Yuzhen tsentralen	359.7	358.7	370.4	402.2	436.0	407.3	401.3	379.1	498.7
Plovdiv	146.5	145.7	146.4	132.1	143.3	132.6	125.5	114.4	141.9
Haskovo	66.5	77.7	78.7	84.9	85.5	78.1	73.7	69.6	84.4
Pazardzhik	68.0	52.8	60.7	69.9	68.9	67.0	75.8	78.6	104.6
Smolyan	29.0	45.7	47.5	42.8	52.0	45.6	40.7	41.1	54.0
Kardzhali	49.7	36.8	37.0	72.5	86.3	84.1	85.6	75.5	113.8
Greece	8,029.2	8,260.3	8,184.4	8,448.3	8,172.2	8,403.2	6,989.4	6,877.4	6,574.5
Anatoliki Makedonia, Thraki	673.4	709.4	637.7	707.4	658.0	689.3	508.5	571.7	500.6
Evros	183.7	191.0	167.5	192.2	171.4	189.7	120.4	134.9	124.9
Xanthi	107.6	130.6	89.7	109.2	106.6	107.2	88.6	86.4	73.6
Rodopi	156.9	147.3	139.7	156.5	145.9	146.6	82.7	101.7	93.1
Drama	101.7	111.9	114.0	118.5	112.5	115.2	95.2	108.6	99.2
Kavala	123.5	128.7	126.7	131.1	121.6	130.6	121.5	140.1	109.8
CBA Total	1,251.1	1,284.0	1,213.7	1,385.0	1,374.2	1,369.4	1,172.3	1,206.6	1,315.2

Table 36. Linear regression models for NUTS0, 2 and 3 level units of the Greece – Bulgaria CBA and year 2020 projections for GVA produced from agriculture, forestry and fishing.

NUTS Regions	Linear Regression Model	R^2	2020 Projection for GVA produced from Agriculture, Forestry & Fishing (million euros)
Bulgaria			
Yugozapaden	10.375 t – 20,536	0.61	421.5
Sofia (stolitsa)	0.41 t – 793.67	0.20	34.5
Sofia	1.1767 t – 2298.6	0.22	78.3
Blagoevgrad	8.2617 t – 16,465	0.77	223.6
Pernik	-0.93 t + 1,893	0.55	14.8
Kyustendil	1.465 t – 2,888.9	0.17	70.4
Yuzhen tsentralen	11.402 t – 22,447	0.50	585.0
Plovdiv	-2.56 t + 5,266.7	0.39	95.5
Haskovo			
Pazardzhik	4.185 t – 8,314.9	0.63	138.8
Smolyan	1.2567 t – 2,474.1	0.22	64.3
Kardzhali	8.0217 t – 16,004	0.73	199.8
Greece	-206.71 t + 422,018	0.60	4,463.8
Anatoliki Makedonia, Thraki	23.013 t + 46,747	0.60	260.7
Evros	-8.3367 t + 16,871	0.61	30.8
Xanthi	-4.5467 t + 9,211.5	0.54	27.1
Rodopi	-8.5983 t + 17,361	0.66	-7.5
Drama	-1.0133 t + 2,139.3	0.13	92.4
Kavala	-0.525 t + 1,178.1	0.10	117.6
CBA Total			1,267.2

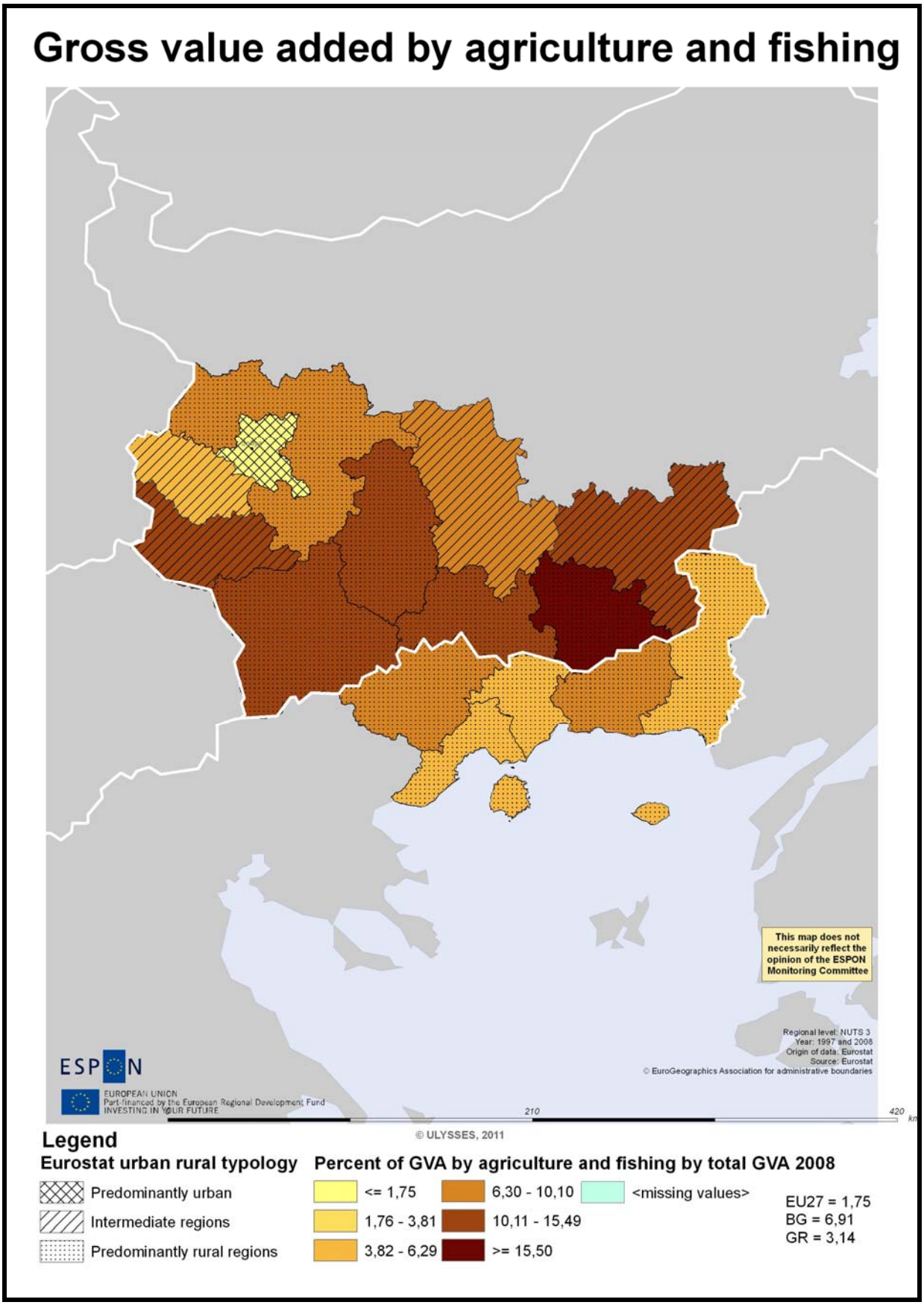

Figure 32. Percentage of GVA produced by Agriculture, Forestry and Fishing, related to the total GVA of each NUTS3 region of the Greece – Bulgaria CBA, for the year 2008.

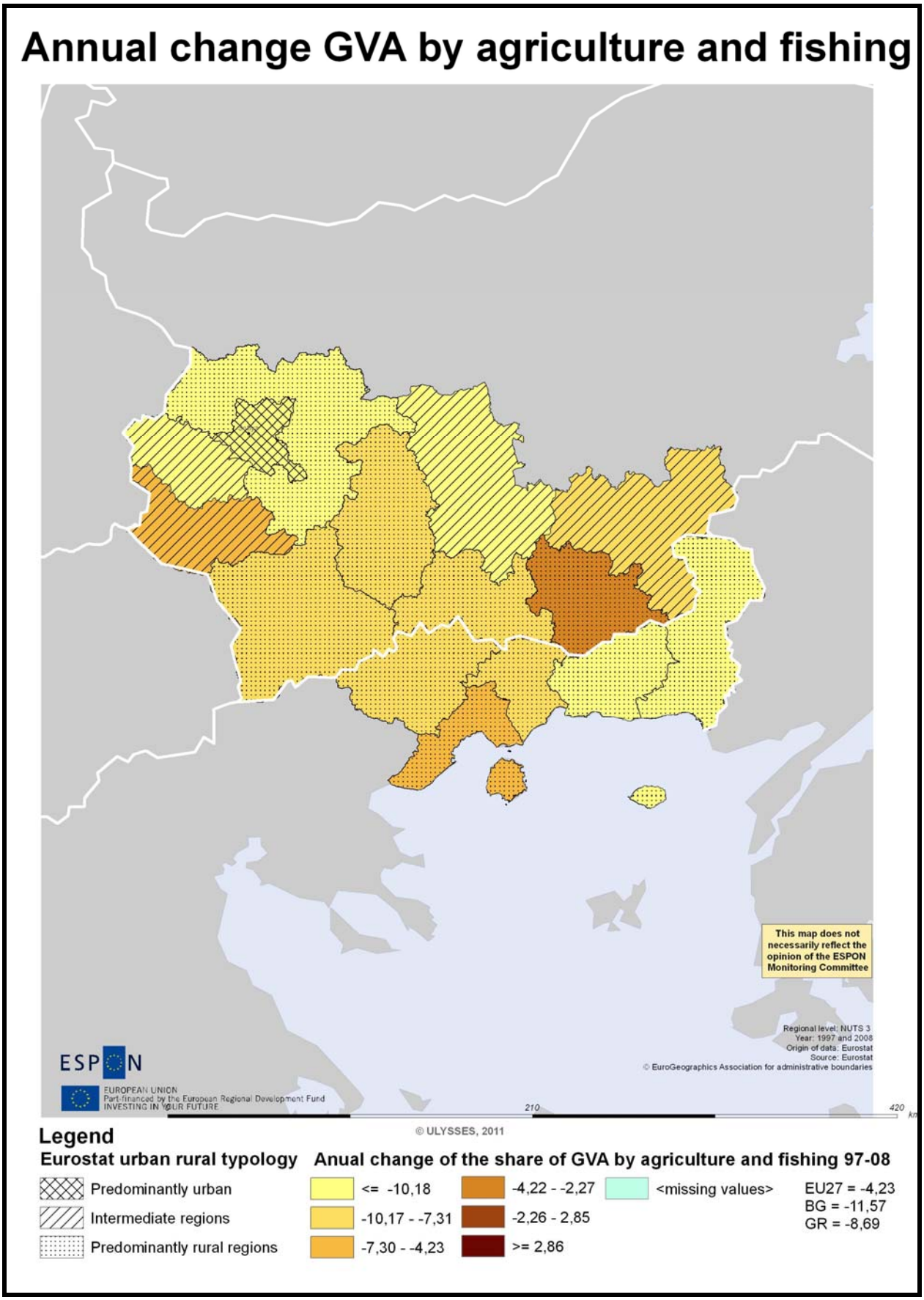

Figure 33. Annual change of GVA produced by Agriculture, Forestry and Fishing in each NUTS3 region of the Greece – Bulgaria CBA, for the period 1997-2008.

4.5. Land Cover

Land cover is here taken as an indicator of degree of human intervention. Harmonised data of land cover are made available by the CORINE dataset. In this data set, the total land cover is divided into three main categories: artificial surfaces, agricultural land and a residual group. Artificial surfaces consist of urban fabric, industrial, commercial and transport units, mine, dump and construction sites, and artificial, non-agricultural vegetated areas. Agricultural areas include arable land, permanent crops, pasture and heterogeneous agricultural areas. The residual group is composed by forest and semi-natural areas (forests, scrub and/or herbaceous vegetation associations, open spaces with little or no vegetation), wetlands (inland wetlands, maritime wetlands), and water bodies (inland waters, maritime waters).

Agricultural land is supposed to reflect a lesser degree of human intervention than artificial surface. The residual group consists of land cover such as forest and semi-natural areas, wetlands and water bodies. On NUTS3 level, the relative share of each of these three categories is available as part of the whole land cover of each NUTS3 area. In order to avoid presumably unreliable and baseless sophistication at the NUTS3 level, only the three main categories were employed.

The European average of artificial surfaces was 3.48% of the total land cover. The corresponding figure of agricultural land was 50.36% and of the residual group it was 46.16%.

Table 37 presents the coverage in agricultural areas of the NUTS0, 2 and 3 areas in the Greece – Bulgaria CBA, for years 1990, 2000 and 2006, the percentage of agricultural area coverage and mean annual growth rate in agricultural area change. It occurs that Bulgaria has a higher coverage in agricultural area (51.7%) than Greece (40.10%), with the latter showing a higher rate in loosing agricultural areas over time (-2.87%). In NUTS2 level, Yuzhen Tsentralen (BG42) shows the higher coverage in agricultural areas (40.30%), with a slight negative trend, followed by Anatoliki Makedonia, Thraki (38.62%) and Yugozapaden (30.52%). However, Anatoliki Makedonia, Thraki looses agricultural land with a significant average annual rate (-4.07%), while Yugozapaden depicts a high positive trend of +5.10% per year. In terms of NUTS3 level units, Plovdiv (BG421), Haskovo (BG422) and Evros (GR111) show the highest 'rurality' behaviour, with agricultural land coverage over 50% of their total area. The highest negative annual trend in agricultural land change is presented by Sofia stolitsa (BG411, -14.11%), followed by Rodopi (GR113, -7.93%). The highest positive trend is shown in Blagoevgrad (BG413, +9.55%).

Table 37. Agricultural areas coverage, percentage of agricultural area coverage and mean annual growth rate in agricultural area change for the NUTS0, 2 and 3 areas in the Greece – Bulgaria CBA (years 1990, 2000 and 2006).

NUTS Name	Code	Agricultural Areas (ha)			Share in total area (%)	Annual Growth Rate for period 1990-2006 (%)
		1990	2000	2006		
Bulgaria	BG	5,736,649	5,733,282	5,736,404	51.70	-0.03
Yugozapaden	BG41	614,812	614,176	619,849	30.52	+5.10
Sofia (stolitsa)	BG411	50,629	50,539	49,498	36.93	-14.11
Sofia	BG412	216,196	215,975	217,819	30.83	+4.68
Blagoevgrad	BG413	148,959	148,796	151,252	23.47	+9.55
Pernik	BG414	100,711	100,733	100,442	41.95	-1.67
Kyustendil	BG415	98,317	98,133	100,838	33.06	+15.84
Yuzhen tsentralen	BG42	902,142	902,173	901,352	40.30	-0.55
Plovdiv	BG421	318,733	318,733	316,595	53.11	-4.28
Haskovo	BG422	289,650	289,678	291,091	52.64	+3.10
Pazardzhik	BG423	138,989	138,989	138,702	31.12	-1.29
Smolyan	BG424	43,262	43,263	43,123	13.46	-2.01
Kardzhali	BG425	111,508	111,510	111,841	34.81	+1.86
Greece	GR	5,297,145	5,281,942	n.d.	40.10	-2.87
Anatoliki Makedonia, Thraki	GR11	549,134	546,682	n.d.	38.62	-4.07
Evros	GR111	219,576	218,587	n.d.	51.50	-4.51
Xanthi	GR112	65,677	65,301	n.d.	36.30	-5.74
Rodopi	GR113	117,882	116,951	n.d.	45.80	-7.93
Drama	GR114	73,574	73,438	n.d.	21.20	-1.85
Kavala	GR115	72,425	72,405	n.d.	34.10	-0.28
CBA Total		2,066,088	2,063,031		36.30	-1.35

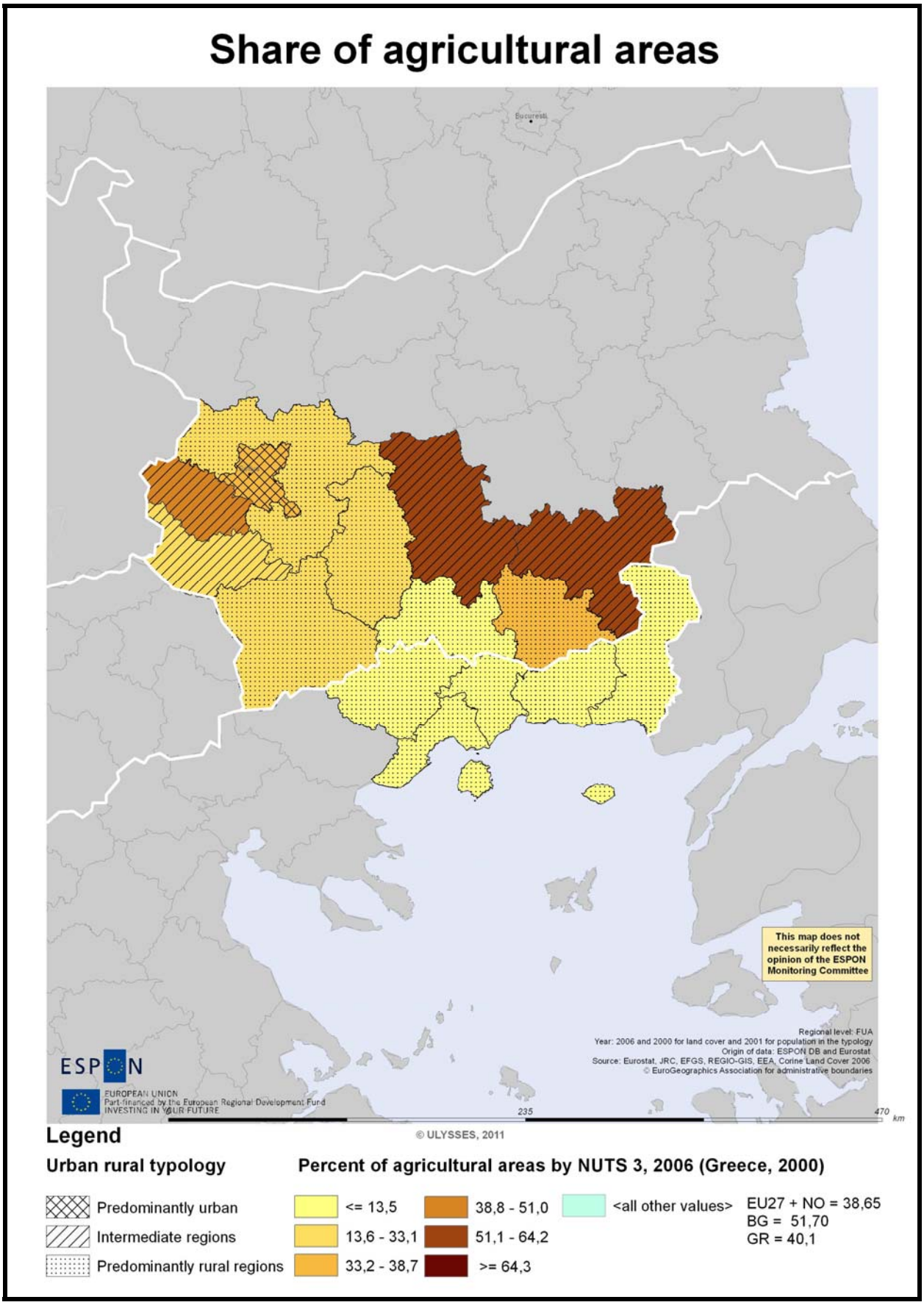

Figure 34. Percentage of agricultural area coverage for the NUTS3 areas in the Greece – Bulgaria CBA (year 2006).

Overall, the Greece – Bulgaria CBA shows a medium negative trend in agricultural areas change (-1.35% per year) having a coverage percent of 36.30. Figure 34 illustrates the NUTS3 areas distribution, based on the coverage in agricultural areas. A cluster of low agricultural area coverage (<13%) is formed between the Greek NUTS3 areas and Smolyan (BG424). Another group is formed consisting of Pazardzhik (BG423), Blagoevgrad (BG413) and Sofia (BG412) with intermediate agricultural area coverage levels (33-38%), while the group of Plovdiv (BG421) and Haskovo (BG422) has the higher agricultural area coverage (>50%).

Table 38 presents the present status of artificial areal coverage, its formation and loss during the period 2000-06, and the share of change from agricultural and natural areas into artificial areas for each NUTS3 area of the Greece – Bulgaria CBA. It occurs that based on CORINE data, within the CBA approximately 2,981 ha of land cover (corresponding to 4.93% of total land cover) were transformed into artificial areas, during the study period. This transformation involved the change of 1.85% of total CBA land cover from agricultural areas into artificial areas and 0.94% from natural areas into artificial areas. As expected, the highest change from agricultural into artificial areas occurred in Sofia stolitsa (BG411, 44.32%). The highest change of natural areas into artificial areas was observed in Blagoevgrad (BG413, 3.15%), followed by Kardzhali (BG425, 2.11%). In Anatoliki Makedonia, Thraki land use transformations from agricultural and natural land into artificial surfaces were negligible.

Figure 35 presents the land use change from agricultural into artificial for each NUTS3 area of the Greece-Bulgaria CBA. All areas apart of Sofia stolitsa show a land use change less than 2.8%.

Focusing more on artificial areas, discontinuous urban fabric refers to the land covered by structures, which occupy discontinuous but significant surfaces, like buildings, roads and artificially surfaced areas, even are associated with vegetated areas and bare soils. Based on CORINE classification, to be classified a cluster of urban grid cells as a discontinuous urban fabric area, approximately 30 to 80% of its area should be impermeable. On the contrary, as continuous urban fabric class is assigned when the urban structures and transport network (i.e. impermeable surfaces) occupies more than 80% of the surface area. This coverage percentage pertains to real ground surface.

Based on the above Figure 36 presents the urbanization change (continous and discontinous) in agricultural areas in the NUTS3 areas of the Greece – Bulgaria CBA, during the period 2000-06. Sofia stolitsa (BG411) shows a urbanisation rate of agricultural areas of 10.56%, while all remaining areas show near zero values. Similarly, the urbanization rate of natural areas is near zero for all NUTS areas (Figure 37).

Table 38. Artificial areas coverage, percentage of artificial areal coverage and mean annual growth rate in artificial areas change for the NUTS0, 2 and 3 areas in the Greece – Bulgaria CBA (years 2000 - 2006).

NUTS Name	Formation of new artificial areas (ha)	Loss of artificial areas (ha)	Net formation/loss of artificial areas (ha)	Share of net formation to total land cover (%)	Agricultural to artificial areas (%)	Natural to artificial areas (%)
Bulgaria	4,484.31	391.18	4,093.13	3.69	3.05	0.79
Yugozapaden	1,305.26	90.13	1,215.14	5.98	4.11	1.86
Sofia (stolitsa)	694.28	90.13	604.16	45.07	44.32	0.75
Sofia	195.18	0.00	195.18	2.76	1.40	1.37
Blagoevgrad	336.37	0.00	336.37	5.22	2.07	3.15
Pernik	59.39	0.00	59.39	2.48	0.43	2.05
Kyustendil	20.04	0.00	20.04	0.66	0.00	0.66
Yuzhen tsentralen	349.31	0.00	349.31	1.56	0.95	0.61
Plovdiv	169.37	0.00	169.37	2.84	2.84	0.00
Haskovo	18.36	0.00	18.36	0.33	0.00	0.33
Pazardzhik	62.96	0.00	62.96	1.41	0.27	1.15
Smolyan	0.00	0.00	0.00	0.00	0.00	0.00
Kardzhali	98.62	0.00	98.62	3.07	0.96	2.11
Greece	45.76	0.00	45.76	0.03	0.00	0.03
Anatoliki Makedonia, Thraki	20.81	0.00	20.81	0.15	0.00	0.15
Evros	0.00	0.00	0.00	0.00	0.00	0.00
Xanthi	0.00	0.00	0.00	0.00	0.00	0.00
Rodopi	14.02	0.00	14.02	0.55	0.00	0.55
Drama	6.79	0.00	6.79	0.20	0.00	0.20
Kavala	0.00	0.00	0.00	0.00	0.00	0.00
CBA Total	2,981.41	180.26	2,801.17	4.93	1.85	0.94

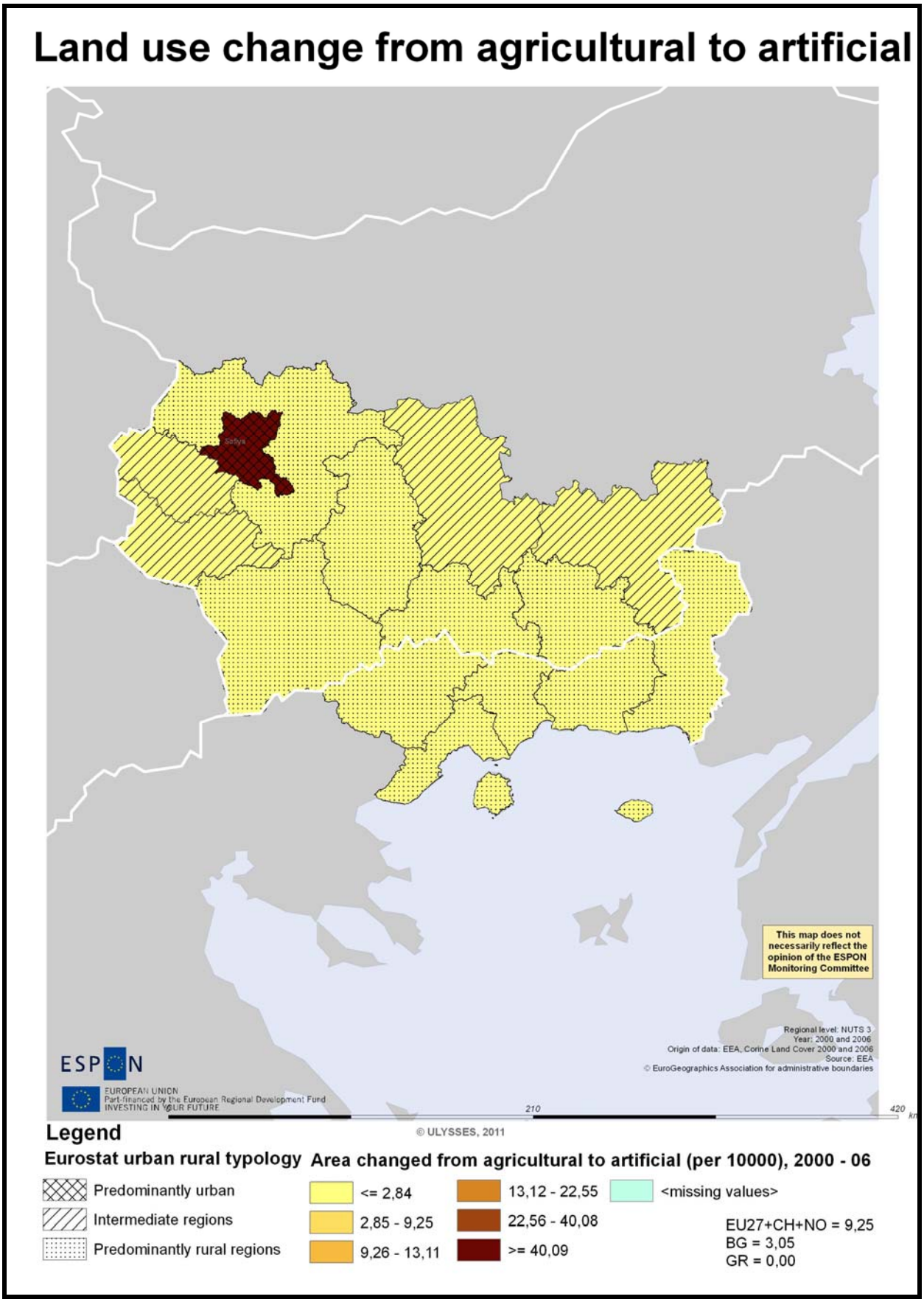

Figure 35. Percentage of land use change from agricultural into artificial areal coverage for the NUTS3 areas in the Greece – Bulgaria CBA (years 2000-06).

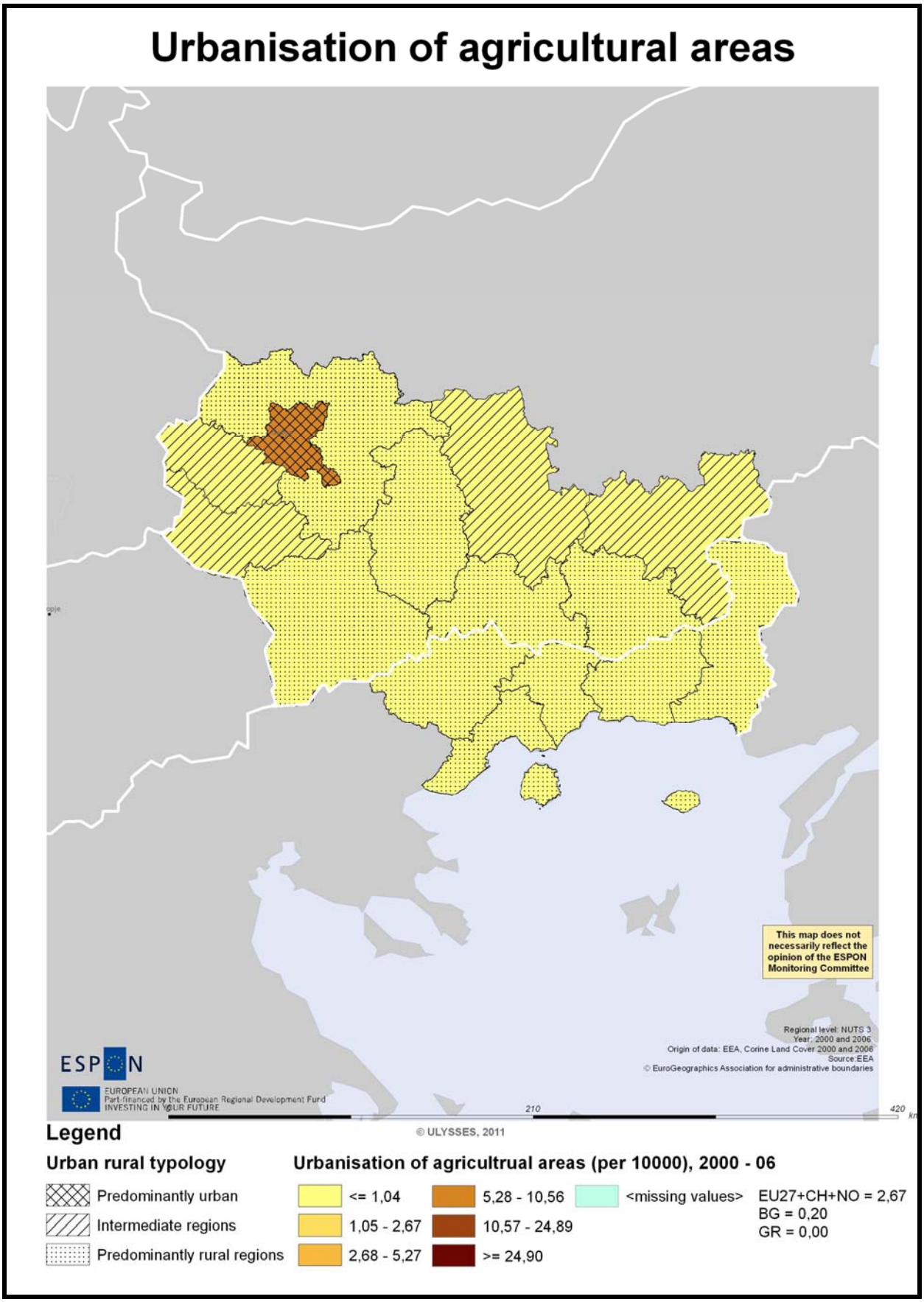

Figure 36. Percentage of urbanization change of agricultural areas for the NUTS3 areas in the Greece – Bulgaria CBA (years 2000-06).

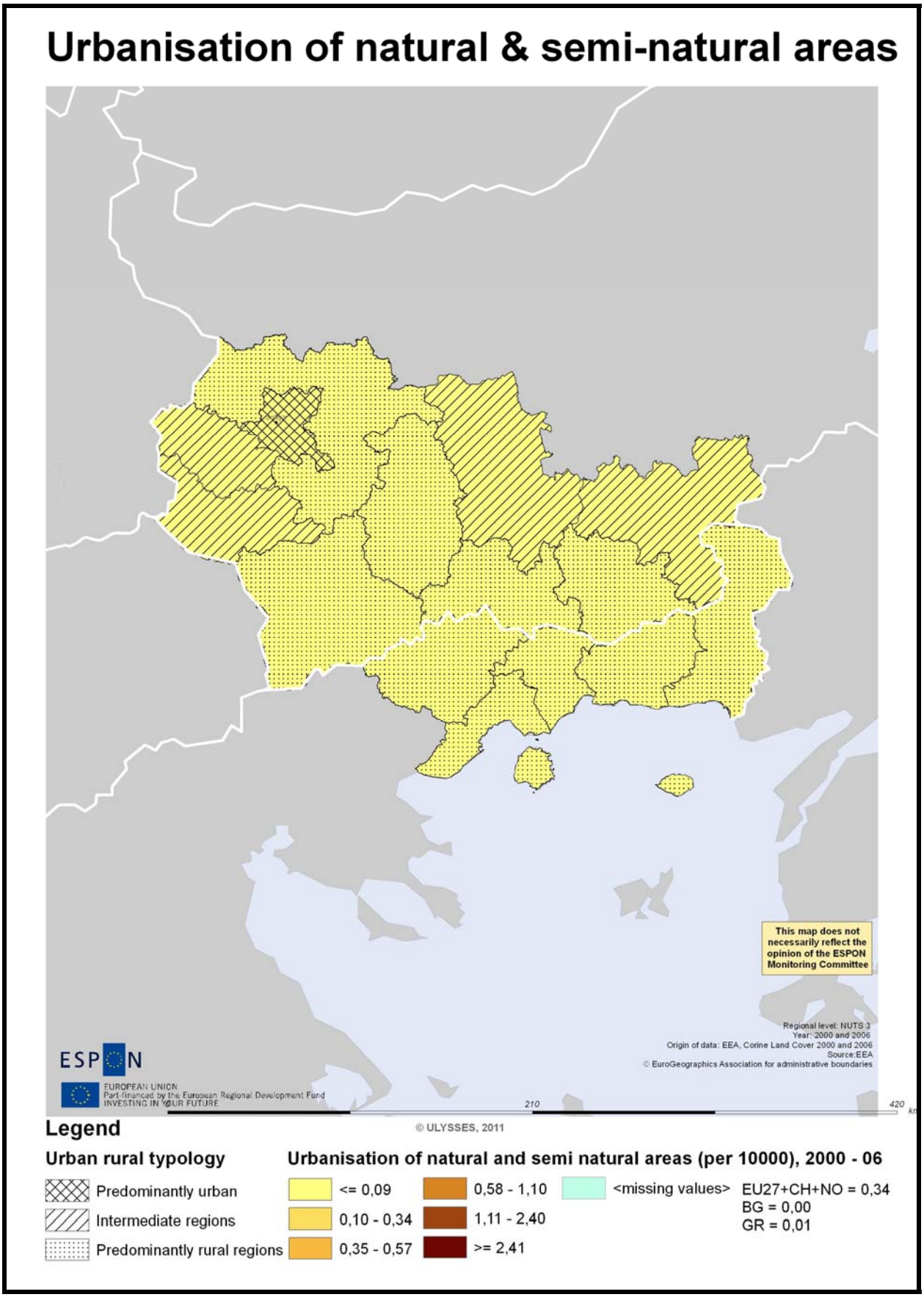

Figure 37. Percentage of urbanization change of natural areas for the NUTS3 areas in the Greece – Bulgaria CBA (years 2000-06).

4.6. Urban – Rural Typology

Based on the above parameters (population density, urban – rural population, employment in agriculture, forestry and fishing, produced GVA by the sector of agriculture, forestry and fishing, and land cover and land use, the two main existing urban – rural typologies were followed:

A) The Eurostat urban – rural typology, in which regions are classified into three classes: predominantly urban, intermediate and predominantly rural, and

B) the ESPON 1.1.2 urban – rural typology, in which regions are classified according to the urban – rural influence and the low – high human intervention.

Figure 38 was developed to illustrate NUTS3 areas of the Greece – Bulgaria CBA according to these merged typologies.

Eurostat typology classifies Sofia stolitsa (BG411) as a Predominantly Urban Area, regions Kyustendil (BG415), Pernik (BG414), Plovdiv (BG412) and Haskovo (BG422) as Intermediate Areas, and all remaining regions as predominantly rural areas.

ESPON 1.1.2 typology classifies the whole Anatoliki Makedonia, Thraki (GR11) and regions Blagoevgrad (BG413), Smolyan (BG424) and Kardzhali (BG425) as areas of Low Urban Influence and Low Human Intervention. Haskovo (BG422), Pazardzhik (BG423), Sofia (BG412) and Pernik (BG414) as areas of Low Urban Influence and Medium Human Intervention, while Sofia stolitsa (BG411) and Plovdiv (BG412) are considered as areas of High Urban Influence and High Human Intervention.

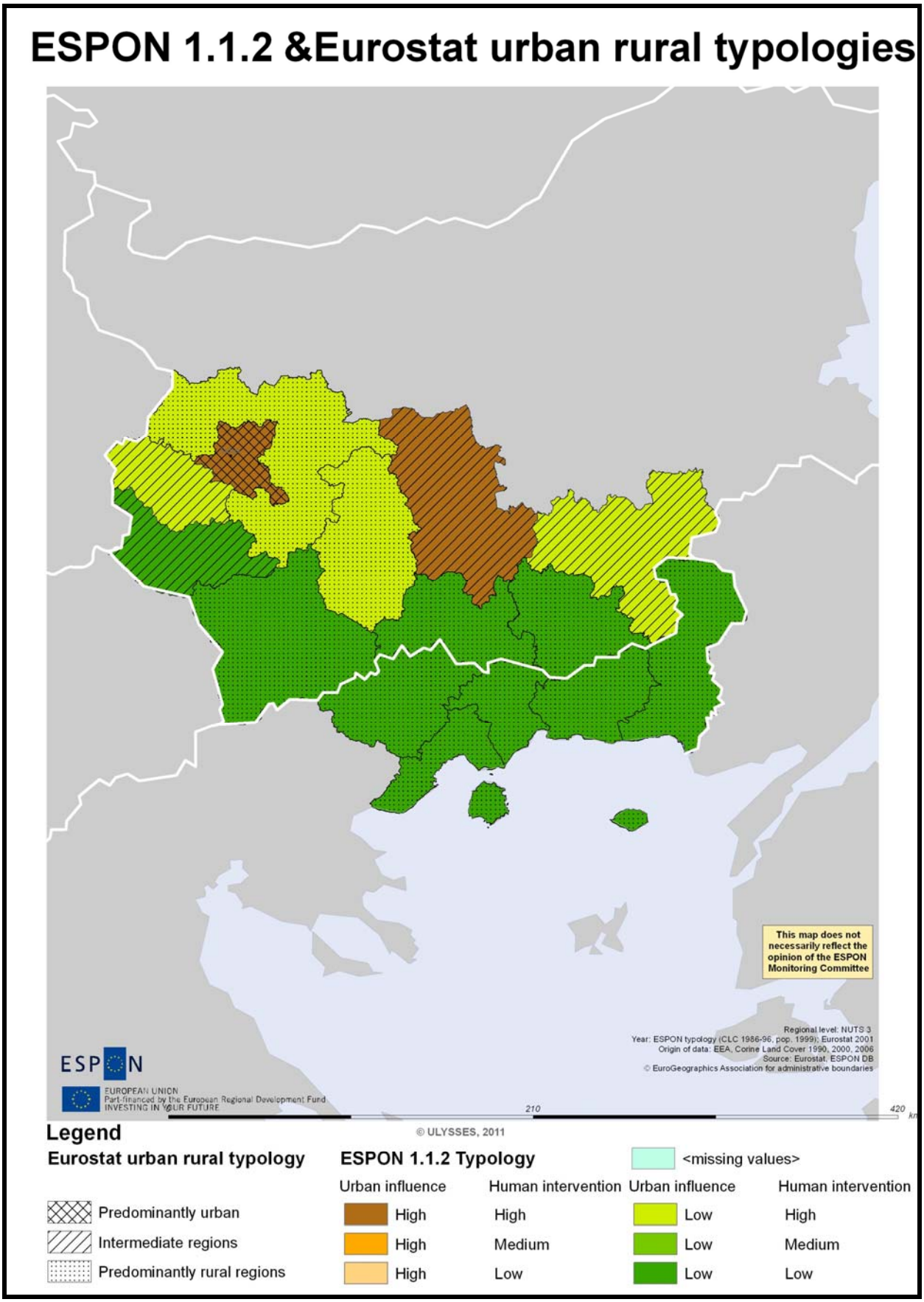

Figure 38. Classification of NUTS3 areas of the Greece – Bulgaria CBA according to the merged Eurostat and ESPON 1.1.2 urban – rural typology.

4.7. Chapter Conclusions

- Urban-rural relationships of the Greece – Bulgaria CBA were examined in terms of population density, urban-to-rural population shares, employment and GVA in the primary sector and land type coverage.
- In most NUTS3 regions, population density depicted a decreasing trend over the last decade. Linear population density projections showed that by year 2020 most NUTS3 level units are expected to be characterised as 'strongly rural areas' (having population density below 50 inh per sq km), thus experiencing strong depopulation. Sofia stolitsa is the only 'strongly urban area' of the CBA and Plovdiv the only 'moderately urban area'.
- Urban-to-rural population analysis showed that Rodopi (GR113) is the most rural NUTS3 area of the region, having the 51.43% of its total population living in urban centres. Over the last five years a gradual increase in urbanism has occurred, as urban population increased by 0.23% per year in Yugozapaden (BG41) and by 0.42% per year in Yuzhen Tsentralen (BG42).
- In terms of primary sector employment, the Greece – Bulgaria CBA seems to be characterized by an increased 'level of ruralism', as approximately 15.85% of the economically active population are employed in the agriculture, forestry and fishing sector. This increased primary sector employment appears mostly affected by employment in Yuzhen tsentralen (BG42), where almost 27% of the total economically active population is employed in this sector. In Anatoliki Makedonia, Thraki (GR11) this percentage reduces to approximately 25%, while in Yugozapaden (BG41) rural employment is diminished to only 7.6%.
- Rural employment over the last decade shows a gradual reduction trend of 1.2% per year; in Anatoliki Makedonia, Thraki this reduction is the highest, reaching 3.5% per year.
- The produced GVA in the agriculture, forestry and fishing sector of the CBA was of the order of 1.3 billion euros in 2008. Plovdiv (BG421), Blagoevgrad (BG413), Evros (GR111) and Kardzhali (BG425) are producing the higher GVA in the CBA. GVA's temporal variability depicts an increasing tendency through time in Bulgarian areas (>10%), especially those close to the borderline. All Greek areas show a strong opposite effect, following well the national trend (from -7 to -10%).
- In terms of land coverage, the Greece – Bulgaria CBA shows a medium negative trend in agricultural areas change (-1.35% per year) having a coverage of 36.3%. Yuzhen Tsentralen (BG42) shows the higher coverage in agricultural areas (40.30%), with a slight negative trend, followed by Anatoliki Makedonia, Thraki (38.62%) and Yugozapaden (30.52%). Anatoliki Makedonia, Thraki looses agricultural land with a significant average annual

rate (-4.07%), while Yugozapaden depicts a high positive trend of +5.10% per year.

- During the 2000-06 period approximately 4.93% of total CBA land cover was transformed from agricultural into artificial areas. As expected, the highest change from agricultural into artificial areas occurred in Sofia stolitsa (BG411, 44.32%). The highest change of natural areas into artificial areas was observed in Blagoevgrad (BG413, 3.15%), followed by Kardzhali (BG425, 2.11%). In Anatoliki Makedonia, Thraki land use transformations from agricultural and natural land into artificial surfaces were negligible.
- Overall, based on Eurostat typology, Sofia stolitsa (BG411) is classified as a 'Predominantly Urban Area'; Kyustendil (BG415), Pernik (BG414), Plovdiv (BG412) and Haskovo (BG422) as 'Intermediate Areas', and all remaining regions as 'Predominantly Rural Areas'.
- Based on ESPON 1.1.2 typology, the whole Anatoliki Makedonia, Thraki (GR11) and the regions of Blagoevgrad (BG413), Smolyan (BG424) and Kardzhali (BG425) are classified as areas of 'Low Urban Influence and Low Human Intervention'. Haskovo (BG422), Pazardzhik (BG423), Sofia (BG412) and Pernik (BG414) are characterised as areas of 'Low Urban Influence and Medium Human Intervention', while Sofia stolitsa (BG411) and Plovdiv (BG412) are considered as areas of 'High Urban Influence and High Human Intervention'.

Chapter 5 – Accessibility & Connectivity Analysis

5.1. Aims, Indicators and Methods

Accessibility is the main 'product' of a transport system. While transportation is generally thought of as the way to reach or move something through space, the ability to transport can be defined as accessibility (Black, 2003). In more general terms, accessibility is an important factor for competitiveness of places, determining their economic success (Biehl, 1991; MacKinnon et al., 2008). It is closely related to mobility, economic development, social welfare and environmental impacts. Therefore, accessibility can be considered as a proxy of a set of related (economic, social, environmental) effects of transport infrastructure.

Accessibility determines the locational advantage of an area (i.e. in ESPON a region, a city or a corridor) relative to all areas (including itself). Indeed, accessibility analyses are gaining momentum in the assessment of plans and projects of transport infrastructure in recent years (Gutiérrez et al., 2010). The important role of transport infrastructure (i.e. networks and transport services) for spatial development in its most simplified form implies that areas with better access to the locations of input materials and markets are expected to be more productive, more competitive and hence more successful than more remote and isolated areas.

Indicators of accessibility measure the benefits households and firms in an area enjoy from the existence and use of the transport infrastructure relevant for their area. Accessibility indicators may be sensitive to the following dimensions: origins, destinations, impedance, constraints, barriers, type of transport, modes, spatial scale, equity and dynamics.

Accessibility indicators may be calculated for road, rail, inland waterways or air. Multimodal accessibility indicators combine several modal accessibility indicators. Intermodal accessibility indicators include trips by more than one mode.

In general terms, accessibility is a construct of two functions, one representing the activities or opportunities to be reached and one representing the effort, time, distance or cost needed to reach them. This is expressed by the function:

$$A_i = \sum_j g(W_j) f(c_{ij})$$

where A_i is the accessibility of area i, W_j is the activity W to be reached in area j, and c_{ij} is the generalised cost of reaching area j from area i. The functions $g(W_{ij})$ and $f(c_{ij})$ are called activity functions and impedance functions, respectively. In fact, A_i is

the total of the activities reachable in areas j weighted by the ease of getting from i to j.

Potential Accessibility is the indicator which is based on the assumption that the attraction of a destination increases with size and declines with distance or travel time or cost. Therefore, both size and distance of destinations are taken into account. The size of the destination is usually represented by area population or some economic indicator such as total area GDP or total area income. The activity function may be linear or nonlinear.

Generally a negative exponential function is used in which a large value of the parameter β indicates that nearby destinations are given greater weight than remote ones. The potential accessibility indicator is therefore defined as:

$$A_i = \sum_j W_j^0 \exp(-\beta c_{ij})$$

A_i 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 exist and the more accessible j-areas are from i-area, the greater is the accessibility of the i-area.

All three types of accessibility indicator can be calculated for any mode of transport. At a European scale, accessibility indicators for road, rail and air are most frequently calculated. There are essentially two ways of integration of modal accessibility indicators to derive the multimodal accessibility indicator. One method is to select the fastest mode to each destination, which in general will be air for distant destinations and road or rail for short- or medium-distance destinations, and to ignore the remaining slower modes. Another way is to calculate an aggregate accessibility measure combining the information contained in the modal accessibility indicators by replacing the generalised cost c_{ij} by a 'composite' generalised cost function.

The aim of this report is the evaluation of the various accessibility and connectivity levels for each NUTS0, 2 and 3 region of the Greece – Bulgaria Cross-Border Area, and to perform cross-border comparisons estimating the general accessibility levels of the CBA regarding the different modes of transportation. In such cross-border areas, transport infrastructure both countries and its independent regions, by 'exporting' and 'importing' benefits produced by the spillover effect, i.e., the benefits a country or a region receives from infrastructure developments construcyed ni neighbour countries or regions. It seems logical to think that the country that has a negative balance should be compensated by the country that presents a positive balance (the Coasian approach).

To fulfil the above target, a set of Accessibility Indicators were used, as presented in Table 39.

Table 39. Demographic Parameters studied for Greece – Bulgaria CBA.

Parameter – Indicator	Period Covered	Data Source	NUTS Unit Level
Potential Accessibility by Road, Rail and Air and Multimodal Accessibility indexed to ESPON average	2001; 2006	ESPON 2013 Database	NUTS 3
Potential Accessibility by Road, Rail and Air and Multimodal Accessibility indexed to CBA average	2001; 2006	ESPON 2013 Database	NUTS 3
Potential Accessibility by Road, Rail and Air and Multimodal Accessibility Index change 2000-2006	2001 – 2006	ESPON 2013 Database	NUTS 3

5.2. Potential Accessibility by Road

The calculation of the updated road potential accessibility indicators for 2001 and 2006 is based on the detailed GIS database of trans-European transport networks which covers all countries of the ESPON space and the remaining European countries and includes all modes of transport (RRG GIS database, 2006). The road network layer of this GIS database are used to calculate the accessibility potential of the NUTS-3 regions of the ESPON countries. More specifically, the road network layer includes all TEN and TINA roads, E-roads, motorways and highways, dual-carriageway roads, as well as other trunk roads and other important national roads and road ferries and other roads to guarantee connectivity of NUTS-3 regions, altogether forming the trunk road network of Europe.

The Potential Accessibility by Road Index for the NUTS3 areas of the Greece – Bulgaria CBA is shown in Table 40. The Table presents the absolute values of the potential accessibility by road, its relative change and the potential accessibility of each NUTS3 area, as related to that of the ESPON Space, for the years 2001 and 2006. As potential accessibility indicators are combinations of two components, the destination activity of interest (here population) and the impedance term (here travel time) can change over time and thus alter the accessibility values. In our analysis, changes in potential accessibility over time can be exclusively attributed to the changes in the transport system, i.e. the effects of changes in the distribution of population are excluded.

Table 40. Potential Accessibility by Road of each NUTS3 region of the Greece – Bulgaria CBA.

NUTS Name	Length of Road Network (km) (2001)	Potential Accessibility by Road (2001)	Potential Accessibility by Road (2006)	Relative Change in Potential Accessibility by Road (2001-06)	Potential Accessibility by Road 2001 (ESPON=100)	Potential Accessibility by Road 2006 (ESPON=100)
Yugozapaden						
Sofia (stolitsa)	243.45	6,442,860	6,943,640	7.8%	39.1	39.2
Sofia	910.78	5,708,840	6,168,860	8.1%	34.6	34.8
Blagoevgrad	447.98	5,115,890	5,602,610	9.5%	31.0	31.6
Pernik	371.19	5,630,220	6,164,680	9.5%	34.1	34.8
Kyustendil	297.36	5,032,740	5,581,340	10.9%	30.5	31.5
Yuzhen tsentralen						
Plovdiv	700.33	6,286,620	6,564,280	4.4%	38.1	37.1
Haskovo	656.60	6,129,740	6,347,540	3.6%	37.2	35.8
Pazardzhik	494.50	5,800,390	6,082,790	4.9%	35.2	34.3
Smolyan	292.59	4,413,280	4,656,540	5.5%	26.8	26.3
Kardzhali	358.02	4,999,960	5,186,390	3.7%	30.3	29.3
Anatoliki Makedonia, Thraki						
Evros	236.32	2,813,130	3,396,140	20.7%	17.1	19.2
Xanthi	264.69	3,099,400	4,035,660	30.2%	18.8	22.8
Rodopi	248.51	3,067,660	3,925,840	28.0%	18.6	22.2
Drama	375.90	3,041,820	3,614,250	18.8%	18.4	20.4
Kavala	296.25	3,233,210	4,142,760	28.1%	19.6	23.4

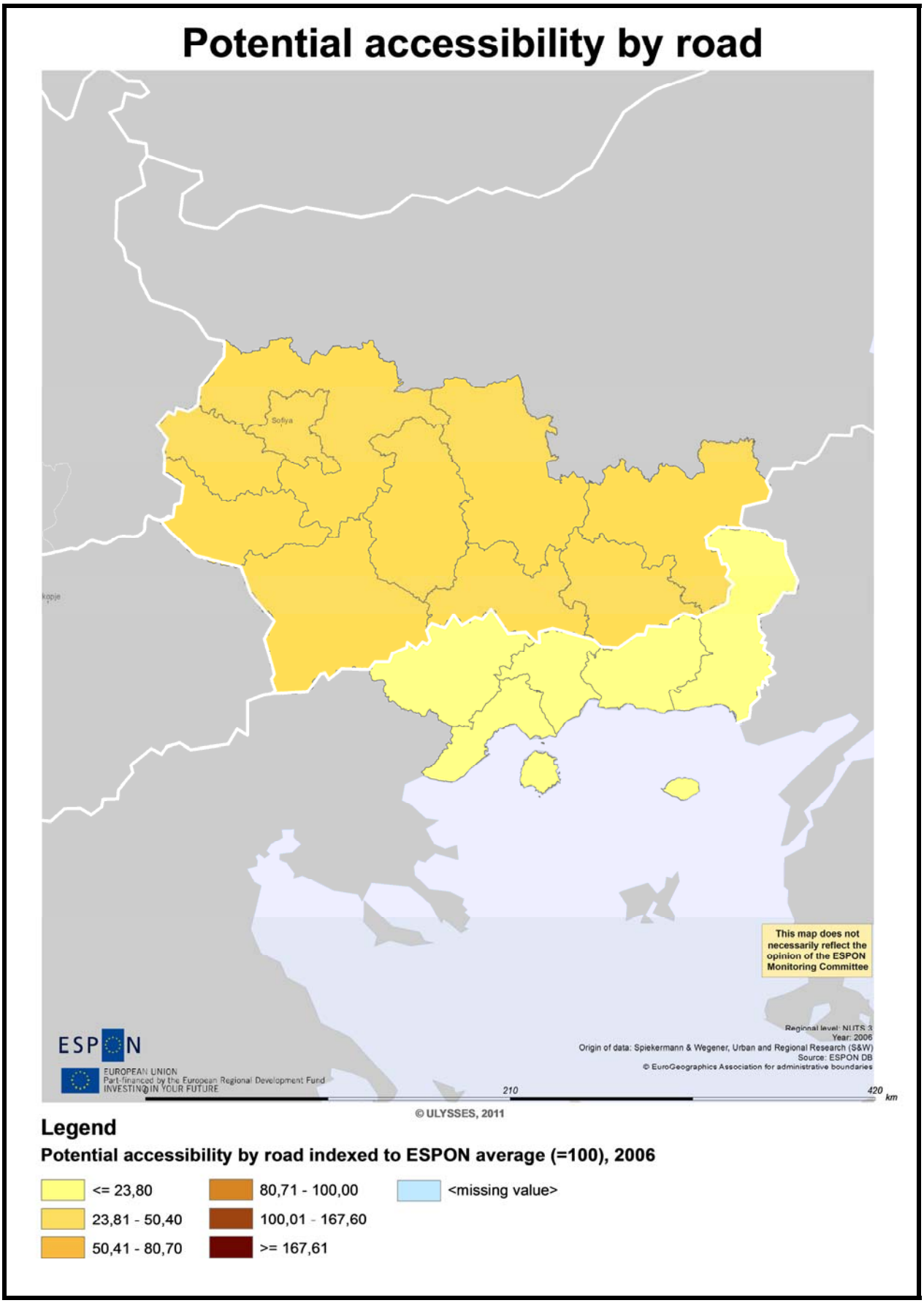

Figure 39. Potential Accessibility by Road Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on ESPON space average (=100), for year 2006.

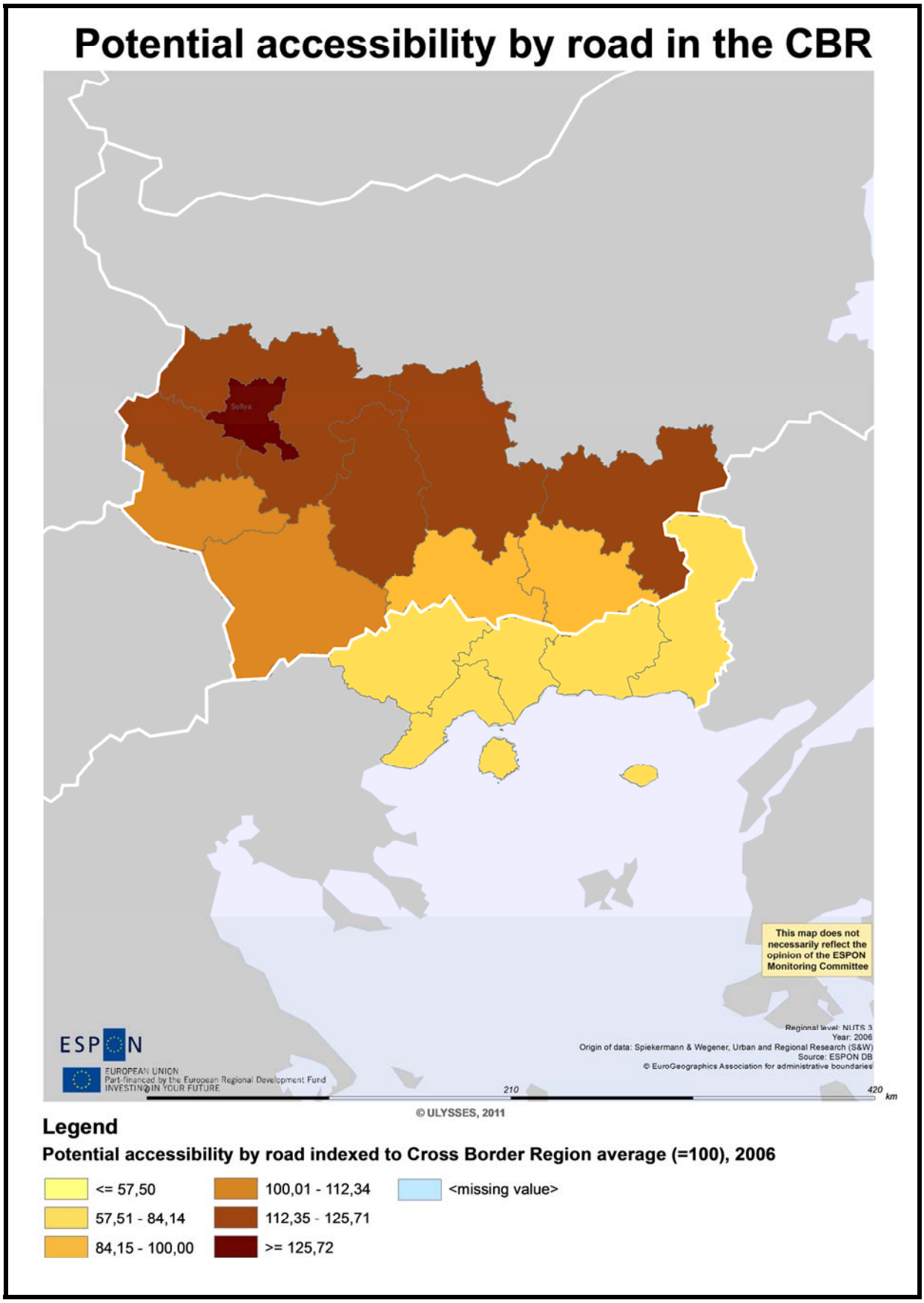

Figure 40. Potential Accessibility by Road Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on CBA space average (=100), for year 2006.

The potential accessibility by road of the NUTS2 areas of Yugozapaden (BG41) and Yuzhen tsentralen (BG42) (34.38 and 32.56, respectively) appears significantly higher than the potential accessibility by road of Anatoliki Makedonia, Thraki (GR11, 21.6). However, this latter area shows a strong improvement in the potential accessibility index between years 2001 and 2006 (from 18.5 to 21.6). In terms of the NUTS3 areas of the Greece – Bulgaria CBA, Sofia stolitsa (BG411), Plovdiv (BG421) and Haskovo (BG422) show the higher potential accessibility by road indices, while Evros (GR111) and Drama (GR114) depict the lower values.

The pattern of the significant potential accessibility by road assigned to the Bulgarian NUTS3 areas, as compared to the corresponding Greek regions is shown in Figure 39. Figure 40 presents the potential accessibility indices as related to the Greece – Bulgaria CBA average value. Two clusters are formed, the low accessibility group consisting of the Anatoliki Makedonia, Thraki areas, together with Smolyan (BG424) and Kardzhali (BG425) with values between 60 and 90 and the second group of the remaining areas, lying at the north, north-eastern and north-western parts of the CBA, having accessibility by road values >100.

Figure 41 presents the index change in potential accessibility by road, during the period 2001-06. Whereas the previous change maps looked at the change of the absolute values expressed either in relative or in absolute terms, this map type ignores the absolute values and focuses on the change of the relative position of the regions. For this, the accessibility values of 2001 are standardised to the EU27 average of that year and those of 2006 to the average of that year, each EU27 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.

Kyustendil (BG415) depicts the higher positive index change in potential accessibility by road, Anatoliki Makedonia, Thraki (GR11) together with Blagoevgrad (BG413), Sofia stolitsa (BG411), Sofia (BG412) and Pernik (BG414) show a medium positive index change, while Yuzhen tsentralen region (BG42) shows near zero or even slightly negative standardized index change for the 2001-06 period.

5.3. Potential Accessibility by Rail

For the derivation of the potential accessibility index by rail, the railway network of the RRG database was considered. In addition, new planned railway lines based on the TEN and TINA outline plans and outline plans of national transport ministries and railway authorities, and selected railway links currently closed for operation are also included as well as rail ferries. From this railway database two model networks were extracted representing the infrastructure and travel time development between 2001 and 2006.

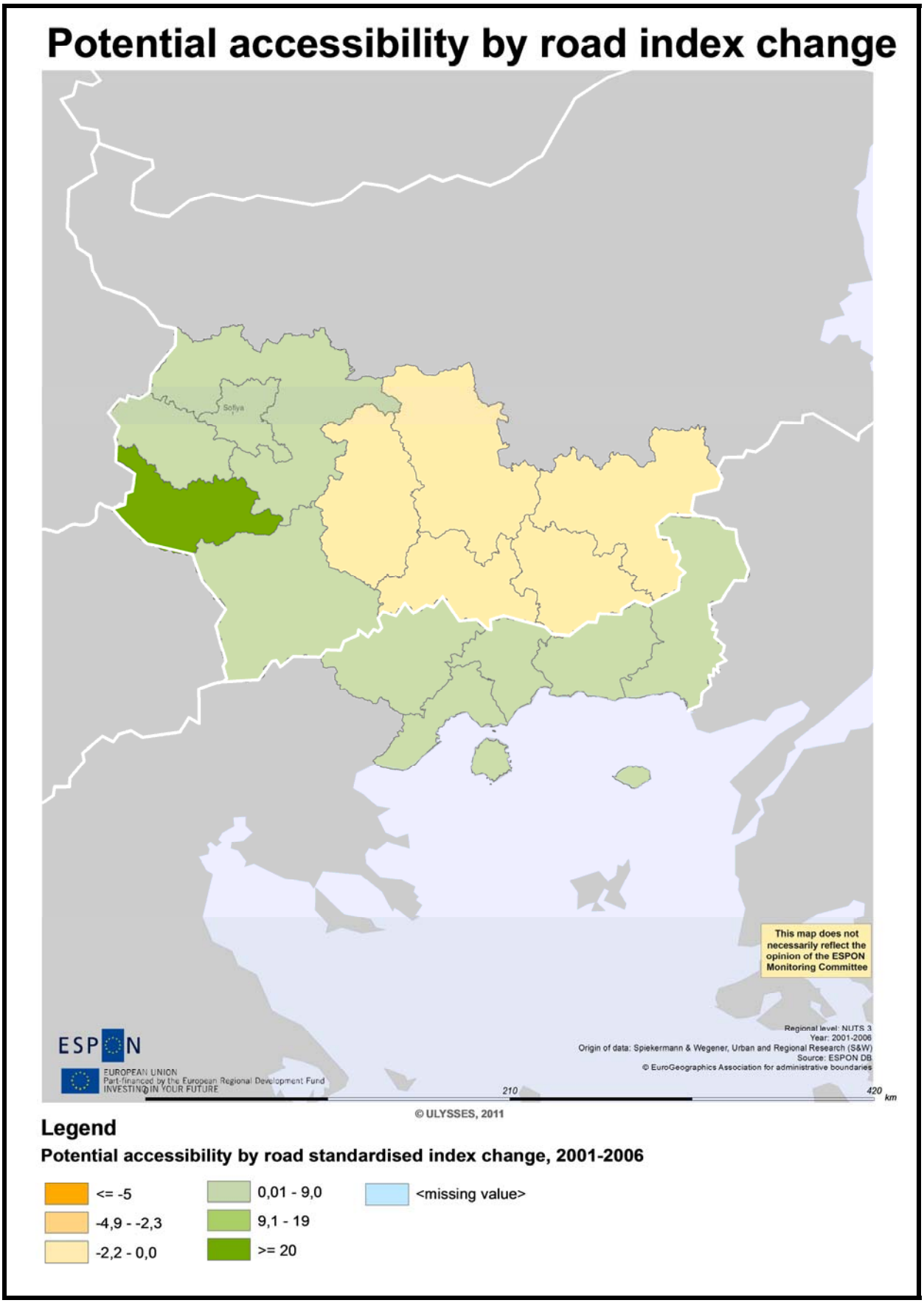

Figure 41. Standardized Index Change in Potential Accessibility by Road of NUTS3 areas of the Greece – Bulgaria CBA, for the period 2001-2006.

Table 41. Potential Accessibility by Rail of each NUTS3 region of the Greece – Bulgaria CBA.

NUTS Name	Length of Railway Network (km) (2001)	Potential Accessibility by Rail (2001)	Potential Accessibility by Rail (2006)	Relative Change in Potential Accessibility by Rail (2001-06)	Potential Accessibility by Rail 2001 (ESPON=100)	Potential Accessibility by Rail 2006 (ESPON=100)
Yugozapaden						
Sofia (stolitsa)	130.21	5,762,190	5,843,220	1.4%	26.0	23.3
Sofia	232.04	4,586,110	4,619,900	0.7%	20.7	18.4
Blagoevgrad	156.47	4,095,790	4,307,340	5.2%	18.5	17.2
Pernik	84.46	5,244,360	5,320,780	1.5%	23.5	21.2
Kyustendil	86.60	3,430,600	3,595,630	4.8%	15.5	14.3
Yuzhen tsentralen						
Plovdiv	287.67	4,907,210	4,780,880	-2.6%	22.1	19.1
Haskovo	168.77	4,334,550	4,163,300	-4.0%	19.5	16.6
Pazardzhik	167.73	4,689,590	4,532,750	-3.3%	21.1	18.1
Smolyan	0.0	3,653,120	3,825,700	4.7%	16.5	15.3
Kardzhali	55.29	3,404,830	3,502,750	2.9%	15.3	14.0
Anatoliki Makedonia, Thraki						
Evros	205.23	2,512,680	3,008,030	19.7%	11.3	12.0
Xanthi	53.33	3,771,880	4,305,530	14.1%	17.0	17.2
Rodopi	65.41	3,301,950	3,868,120	17.1%	14.9	15.4
Drama	59.79	3,118,530	3,593,460	15.2%	14.1	14.3
Kavala	9.08	3,562,040	4,135,980	16.1%	16.1	16.5

The Potential Accessibility by Rail Index for the NUTS3 areas of the Greece – Bulgaria CBA is shown in Table 41. The Table presents the absolute values of the potential accessibility by rail, their relative change and the potential accessibility of each NUTS3 area, as related to that of the average of ESPON Space, set to 100, for the years 2001 and 2006. As potential accessibility indicators are combinations of two components, the destination activity of interest (here population) and the impedance term (here travel time) can change over time and thus alter the accessibility values. In our analysis, changes in potential accessibility over time can be exclusively attributed to the changes in the transport system, i.e. the effects of changes in the distribution of population are excluded.

The average potential accessibility by rail of Yugozapaden (BG41) appears slightly higher (18.88) than that of Yuzhen tsentralen (BG42, 16.62) and Anatoliki Makedonia, Thraki (GR11, 15.08). However, as before, the potential accessibility of Anatoliki Makedonia, Thraki shows significant improvement (mean 16.44%), compared to the other two areas. In terms of the NUTS3 areas of the Greece – Bulgaria CBA, Sofia stolitsa (BG411) and Pernik (BG414) show the highest potential accessibility score, while Evros (GR111), Kardzhali (BG425) and Kyustendil (BG415) demonstrate the lower values.

Figure 42 illustrates the potential accessibility by rail indices, standardized according to the ESPON space average value (100), for the NUTS3 areas of the Greece – Bulgaria CBA. There exists a cross-border cluster of regions, consisting of Evros (GR111), Rodopi (GR112), Kardzhali (BG425), Smolyan (BG424) and Drama (GR114), with limited potential accessibility by rail indices (<15 standardized according to ESPON average value). Figure 43 presents the potential accessibility indices as related to the Greece – Bulgaria CBA average value. Two clusters are formed, the low-to-medium accessibility group consisting of the Anatoliki Makedonia, Thraki areas, together with Smolyan (BG424), Kardzhali (BG425) and Haskovo (BG422), and the medium-to-high accessibility by rail group, lying at the north, north-eastern and north-western parts of the CBA, having accessibility by road values higher than 110 index score.

Figure 44 presents the index change in potential accessibility by road, during the period 2001-06. Again, although the Table 41 presented the change of the absolute values of the accessibility by rail indices, this map type focuses on the change of the relative position of the regions within the EU27 space. 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. Three clusters occur: a) Anatoliki Makedoni, Thraki high-index-change group, b) the Kardzhali (BG425), Smolyan (BG424), Blagoevgrad (BG413) and Kyustendil (BG415) slightly negative to near zero change group, and c) the remaining NUTS areas of the CBA with strongly negative index change behaviour.

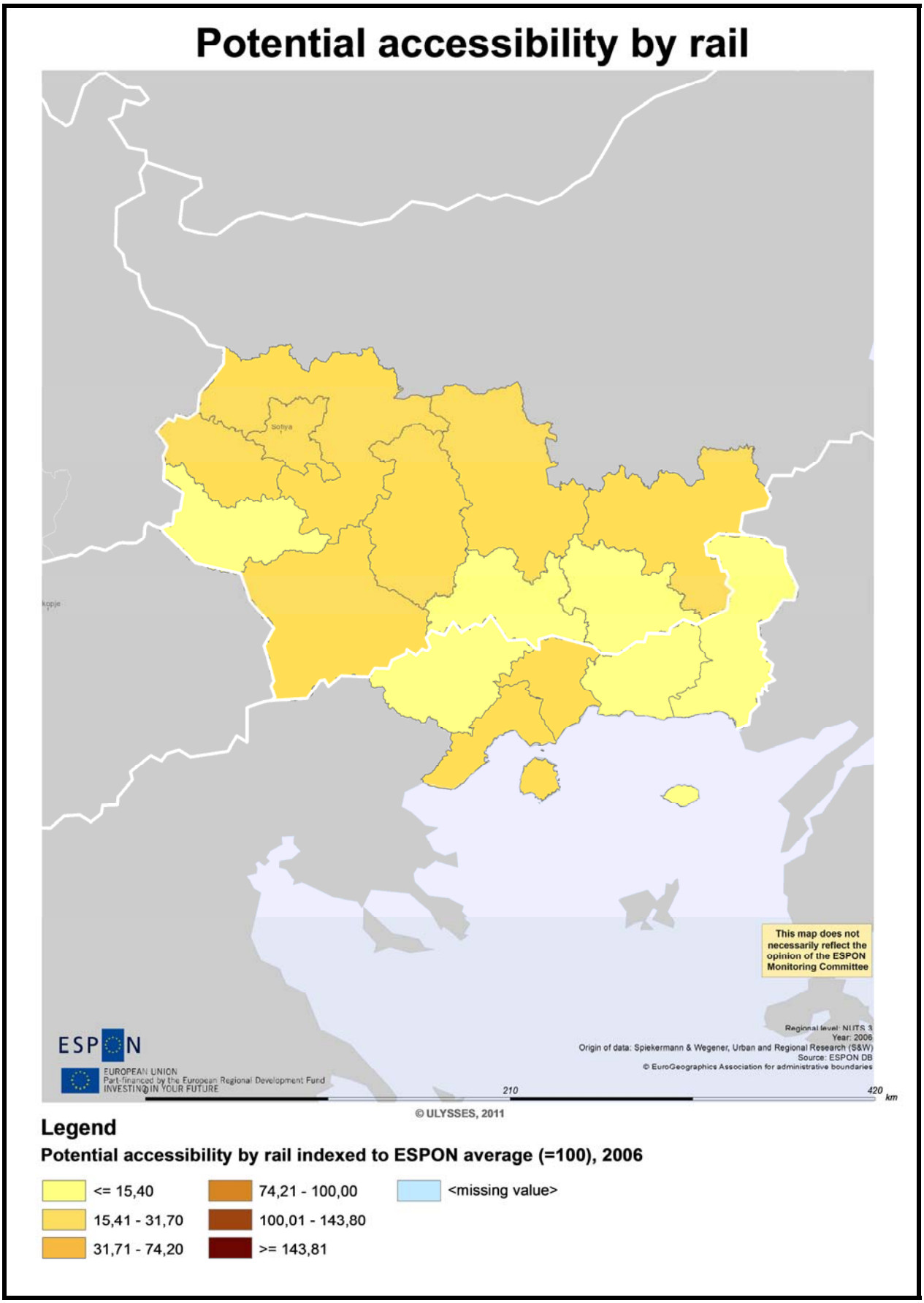

Figure 42. Potential Accessibility by Rail Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on ESPON space average (=100), for year 2006.

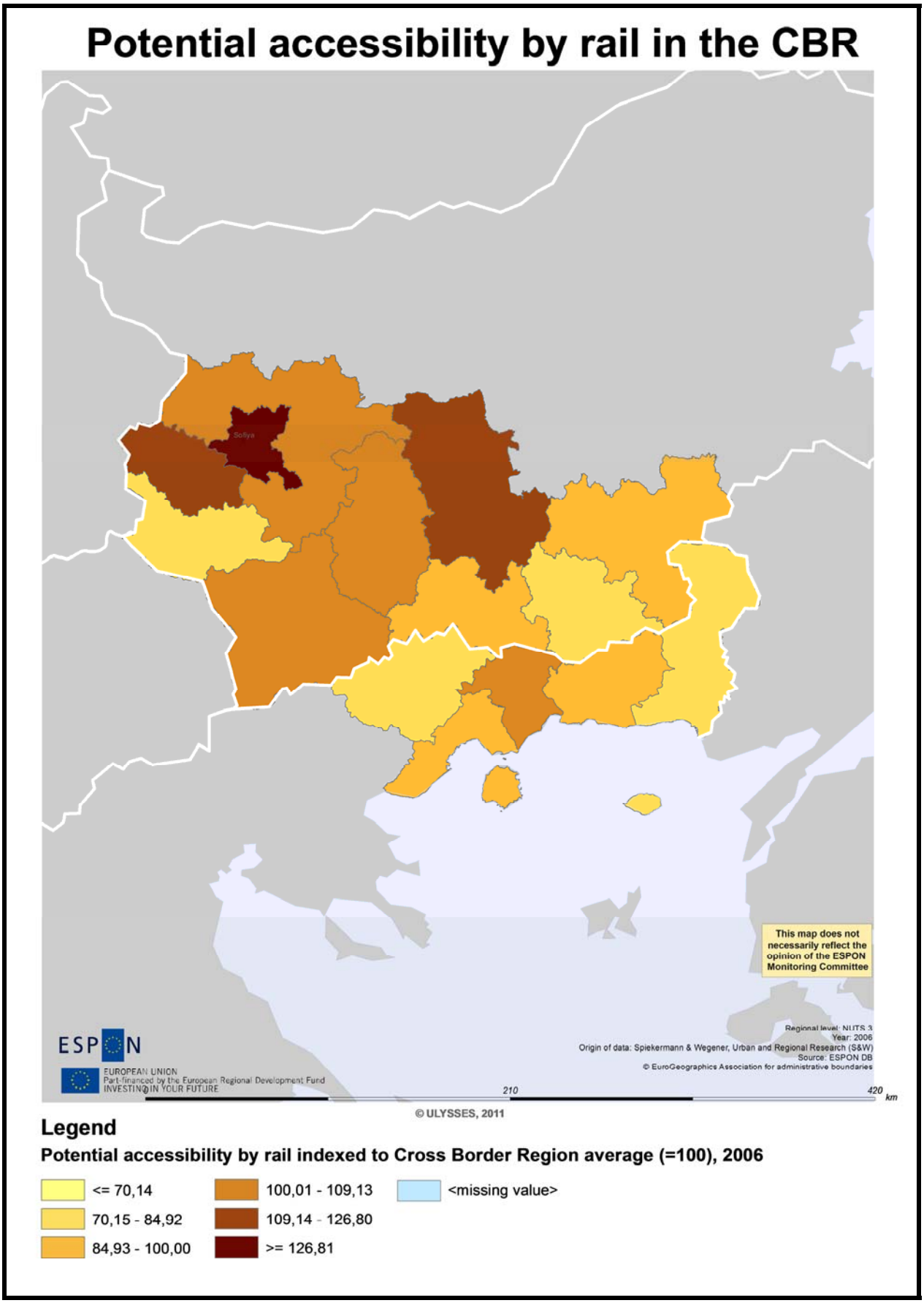

Figure 43. Potential Accessibility by Rail Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on CBA space average (=100), for year 2006.

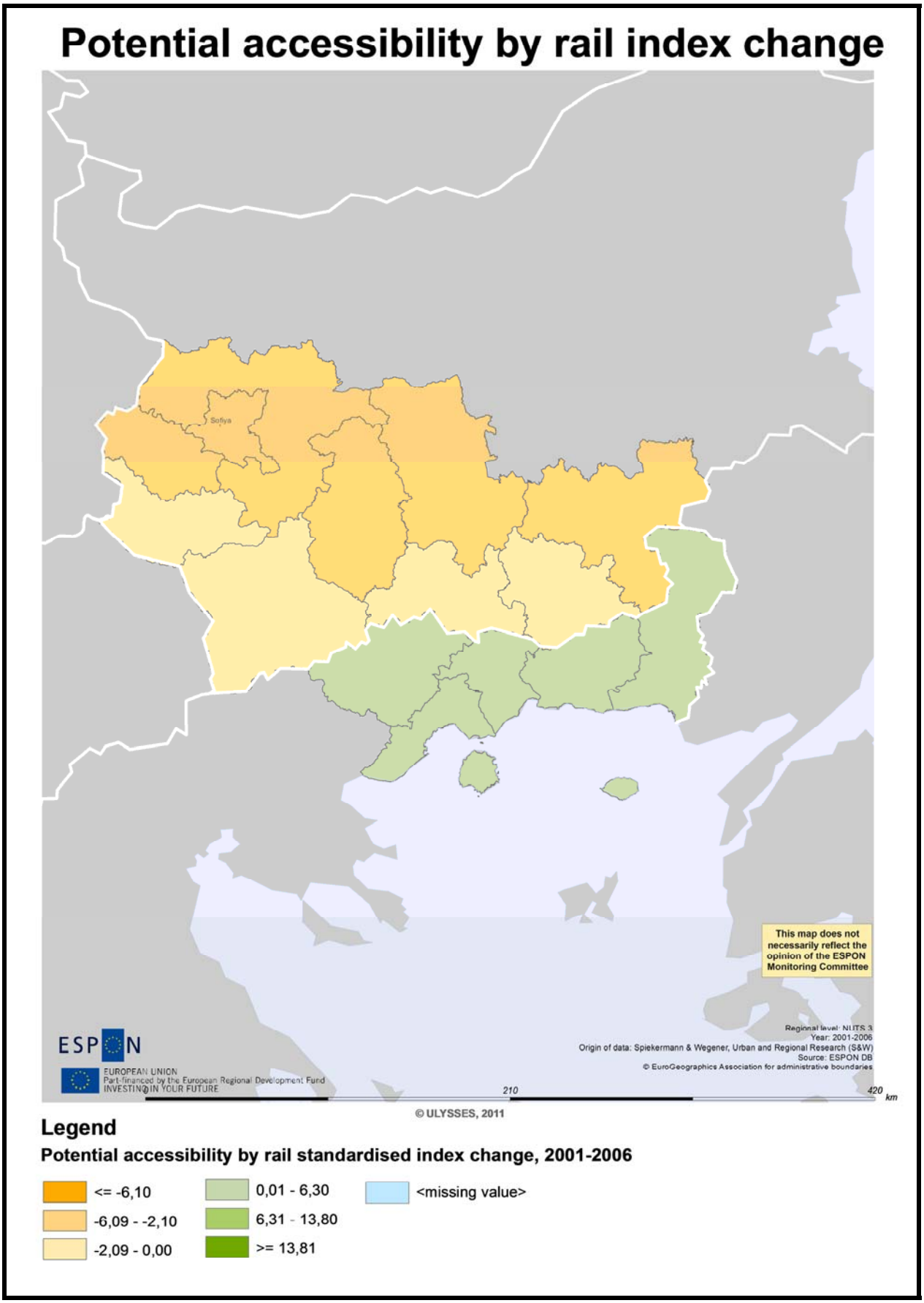

Figure 44. Standardized Index Change in Potential Accessibility by Rail of the NUTS3 areas of the Greece – Bulgaria CBA, for the period 2001-2006.

5.4. Potential Accessibility by Air

The RRG world airport database contains about 9,800 airports of international (world-wide), European and regional importance following the airport classification of the Trans-European Transport Network Outline Plan, Section Airports as specified in Decision 1692/96/EC of the European Parliament and of the Council, as well as airports of the so-called TINA networks (TINA = 'Transport infrastructure needs assessment'; TINA Secretariat, 1999; 2002) for the new member states and candidate countries.

To derive the potential accessibility by air indicator, airline distances represented the geographical distance between two points of interest, measured 'as the crow flies'. Sometimes these distances are also referred to as 'Euclidean distances'.

The Potential Accessibility by Air Index for the NUTS3 areas of the Greece – Bulgaria CBA is shown in Table 42. The Table presents the number of airports, the absolute values of the potential accessibility by air, their relative change and the potential accessibility of each NUTS3 area, as related to that of the average of ESPON Space, set to 100, for the years 2001 and 2006. There exist four airports within the Greece – Bulgaria CBA (Sofia stolitsa, Plovdiv, Evros and Kavala). Based on RERISK 1999 Database, 561.300 passengers were transferred through the two airports of Anatoliki Makedonia, Thraki (GR11), corresponding 1.82% of the national air passenger transport.

As potential accessibility indicators are combinations of two components, the destination activity of interest (here population) and the impedance term (here travel time) can change over time and thus alter the accessibility values. In our analysis, changes in potential accessibility over time can be exclusively attributed to the changes in the transport system, i.e. the effects of changes in the distribution of population are excluded.

The average potential accessibility by air of Yugozapaden (BG41) appears significantly higher (82.54) than that of Anatoliki Makedonia, Thraki (GR11, 46.08) and Yuzhen tsentralen (BG42, 36.66). Moreover, the potential accessibility by air of Yugozapaden (BG41) shows significant improvement (mean 26.44%), in contrast to that of Yuzhen tsentralen (BG42, 17.72%) and Anatoliki Makedonia, Thraki (GR11, 11.58%). In terms of the NUTS3 areas of the Greece – Bulgaria CBA, Sofia stolitsa (BG411) and Pernik (BG414) show the highest potential accessibility score, while Haskovo (BG422) and Kardzhali (BG425) depict the lower values.

Figure 45 illustrates the potential accessibility by air indices, standardized according to the ESPON space average value (100), for the NUTS3 areas of the Greece – Bulgaria CBA. There exists a cross-border cluster of regions, characterised by limited air connectivity consisting of Rodopi (GR112), Drama (GR114), Kardzhali (BG425), Haskovo (BG422), Smolyan (BG424) and Plovdiv (BG421). Figure 46 presents the potential accessibility indices as related to the Greece – Bulgaria CBA average value. Two clusters are formed, the low-to-medium accessibility group

consisting of the Anatoliki Makedonia, Thraki (GR11) and Yuzhen tsentralen (BG42), and the above-average accessibility by air group of Yugozapaden (BG41).

Table 42. Potential Accessibility by Air of each NUTS3 region of the Greece – Bulgaria CBA.

NUTS Name	Number of Commercial Airports (2001)	Potential Accessibility by Air (2001)	Potential Accessibility by Air (2006)	Relative Change in Potential Accessibility by Air (2001-06)	Potential Accessibility by Air 2001 (ESPON=100)	Potential Accessibility by Air 2006 (ESPON=100)
Yugozapaden						
Sofia (stolitsa)	1	45,645,600	58,497,700	28.2%	95.6	113.7
Sofia	0	34,133,000	43,778,600	28.3%	71.5	85.1
Blagoevgrad	0	25,300,500	31,579,200	24.8%	53.0	61.4
Pernik	0	36,294,000	46,172,600	27.2%	76.0	89.7
Kyustendil	0	26,123,300	32,317,800	23.7%	54.7	62.8
Yuzhen tsentralen						
Plovdiv	1	17,122,300	21,289,100	24.3%	35.8	41.4
Haskovo	0	11,461,900	13,186,300	15.0%	24.0	25.6
Pazardzhik	0	21,381,600	27,142,700	26.9%	44.8	52.8
Smolyan	0	16,272,400	18,343,500	12.7%	34.1	35.7
Kardzhali	0	13,045,300	14,315,900	9.7%	27.3	27.8
Anatoliki Makedonia, Thraki						
Evros	1	23,829,400	26,439,600	11.0%	49.9	51.4
Xanthi	0	22,363,400	24,986,700	11.7%	46.8	48.6
Rodopi	0	17,869,000	19,808,800	10.9%	37.4	38.5
Drama	0	18,543,200	20,740,500	11.8%	38.8	40.3
Kavala	1	23,580,400	26,529,200	12.5%	49.4	51.6

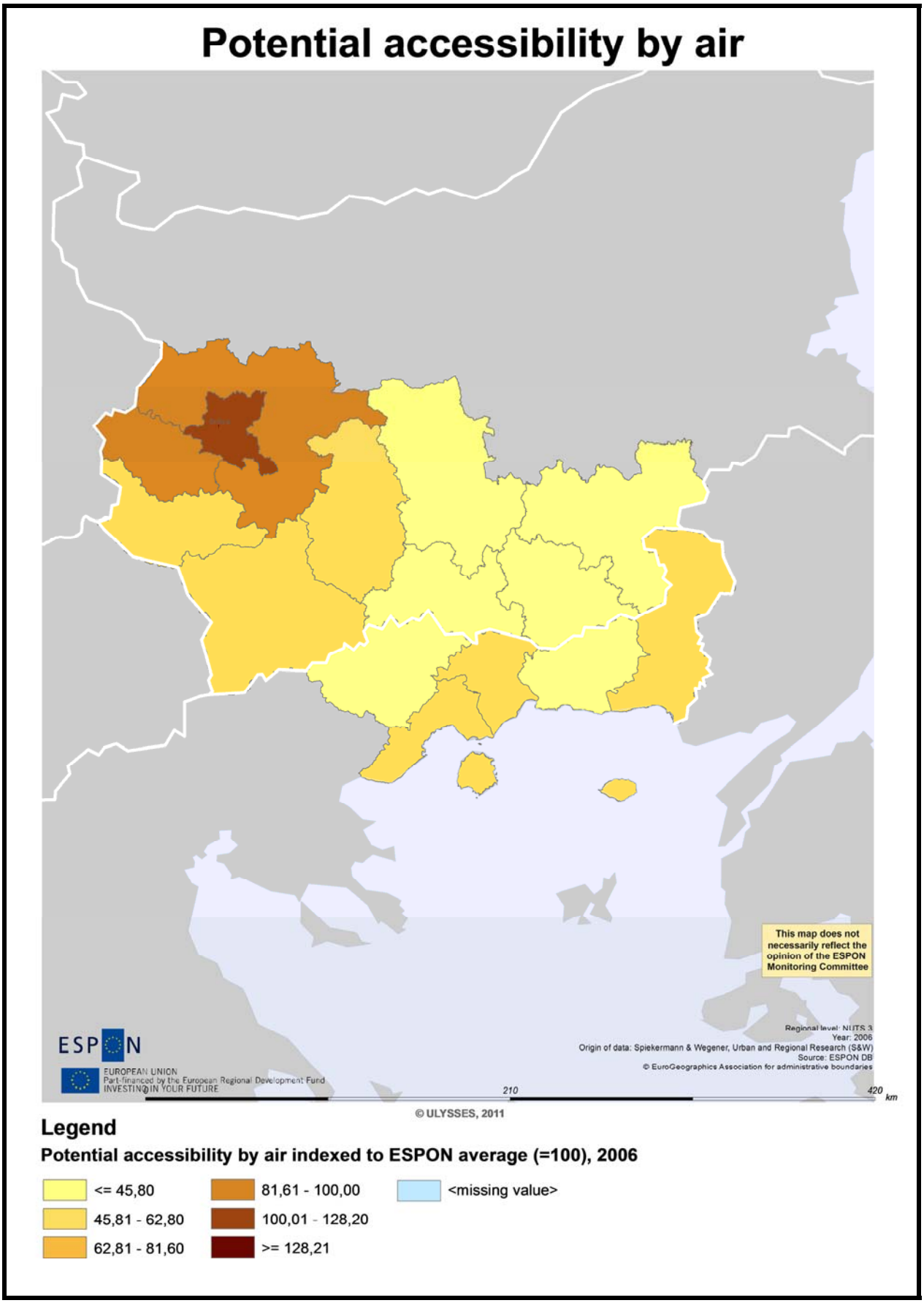

Figure 45. Potential Accessibility by Air Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on ESPON space average (=100), for year 2006.

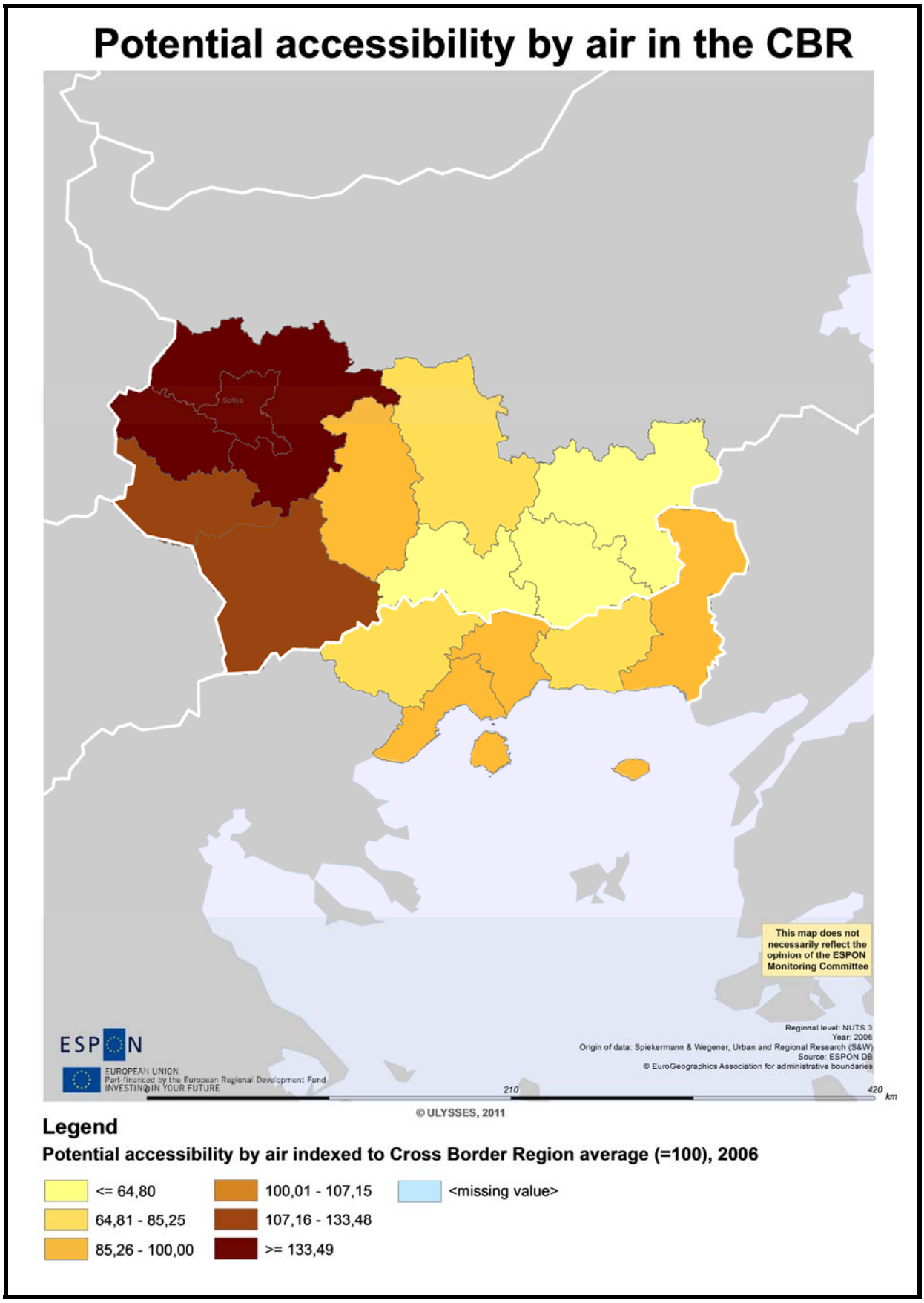

Figure 46. Potential Accessibility by Air Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on CBA space average (=100), for year 2006.

Figure 47 presents the index change in potential accessibility by air, during the period 2001-06. Again, although the Table 41 presented the change of the absolute values of the accessibility by air indices, this map type focuses on the change of the relative position of the regions within the EU27 space. 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. Three clusters occur: a) Anatoliki Makedoni, Thraki (GR11), Kardzhali (BG425), Smolyan (BG424) and Haskovo (BG422) slight improvement group, b) the Plovdiv (BG421), Pazardzhik (BG423), Blagoevgrad (BG413) and Kyustendil (BG415) medium improvement group, and c) the remaining NUTS areas of the CBA with strong positive index change behaviour.

5.5. Multimodal Potential Accessibility

In previous paragraphs, the accessibility trends for transport by road, rail and air have been analysed independently to show differences between the different transport modes. Moreover, these findings were combined into one indicator showing the multimodal potential accessibility of places by analysing the joint effect of the three transport modes. The multimodal accessibility of regions may further be used for investigating relationships between accessibility and economic development and between accessibility and migration, issues that are particular in focus in policy documents related to the European territory.

The Multimodal Potential Accessibility Index for the NUTS3 areas of the Greece – Bulgaria CBA is shown in Table 43. The Table presents the absolute values of the multimodal potential accessibility in 2001 and 2006, its relative change and the multimodal potential accessibility of each NUTS3 area, as related to that of the average of ESPON Space, set to 100, for the years 2001 and 2006.

The average multimodal potential accessibility of Yugozapaden (BG41) appears significantly higher (74.1) than that of Anatoliki Makedonia, Thraki (GR11, 42.02) and Yuzhen tsentralen (BG42, 36.66). Moreover, the multimodal potential accessibility of Yugozapaden (BG41) shows significant improvement (mean 25.14%), in contrast to that of Yuzhen tsentralen (BG42, 13.86%) and Anatoliki Makedonia, Thraki (GR11, 11.70%). In terms of the NUTS3 areas of the Greece – Bulgaria CBA, Sofia stolitsa (BG411), Sofia (BG412) and Pernik (BG414) show the highest multimodal potential accessibility score, while Haskovo (BG422) and Kardzhali (BG425) depict the lower values.

Figure 48 illustrates the multimodal potential accessibility indices, standardized according to the ESPON space average value (100), for the NUTS3 areas of the Greece – Bulgaria CBA. There exists a cross-border cluster of regions, characterised by increased multimodal connectivity (>75) consisting of Sofia stolitsa (BG411), Sofia (BG412) and Pernik (BG414). This group shows strong positive trend, moving towards ESPON mean multimodal accessibility value.

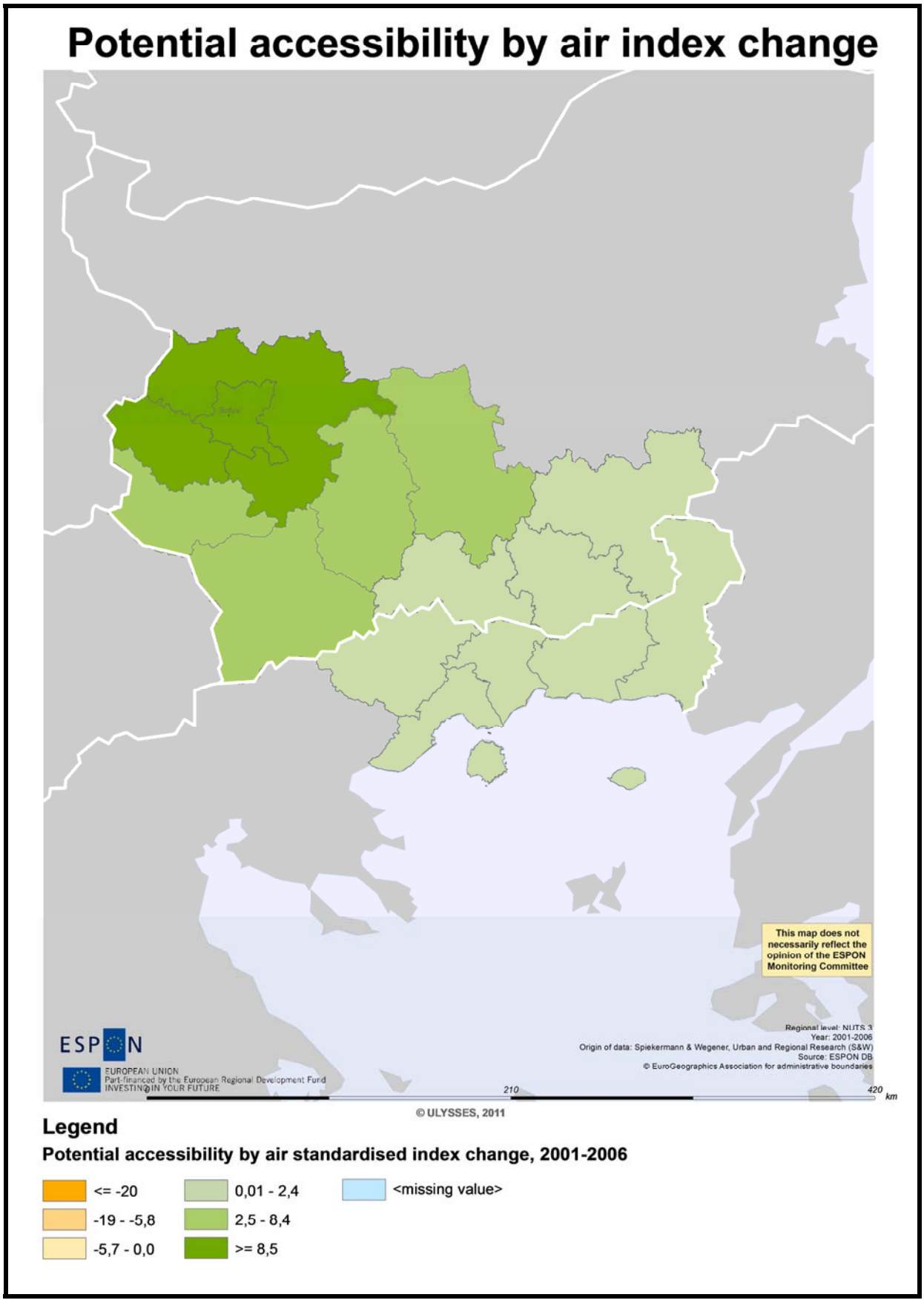

Figure 47. Standardized Index Change in Potential Accessibility by Air of the NUTS3 areas of the Greece – Bulgaria CBA, for the period 2001-2006.

Table 43. Multimodal Potential Accessibility of each NUTS3 region of the Greece – Bulgaria CBA.

NUTS Name	Multimodal Potential Accessibility (2001)	Multimodal Potential Accessibility (2006)	Relative Change in Multimodal Potential Accessibility (2001-06)	Multimodal Potential Accessibility 2001 (ESPON=100)	Multimodal Potential Accessibility 2006 (ESPON=100)
Yugozapaden					
Sofia (stolitsa)	47,263,100	59,849,500	26.6%	86.3	100.6
Sofia	36,011,200	45,453,100	26.2%	65.7	76.4
Blagoevgrad	26,895,800	33,309,000	23.8%	49.1	56.0
Pernik	38,059,200	47,848,500	25.7%	69.5	80.4
Kyustendil	27,542,900	34,000,300	23.4%	50.3	57.1
Yuzhen tsentralen					
Plovdiv	20,641,900	24,514,200	18.8%	37.7	41.2
Haskovo	15,635,100	17,226,900	10.2%	28.5	28.9
Pazardzhik	24,361,100	29,712,000	22.0%	44.5	49.9
Smolyan	18,336,600	20,344,100	10.9%	33.5	34.2
Kardzhali	16,109,200	17,299,500	7.4%	29.5	29.1
Anatoliki Makedonia, Thraki					
Evros	24,337,700	27,161,500	11.6%	44.4	45.6
Xanthi	23,749,000	26,487,600	11.5%	43.3	44.5
Rodopi	19,149,000	21,371,800	11.6%	34.9	35.9
Drama	19,843,300	22,076,800	11.3%	36.2	37.1
Kavala	24,848,300	27,954,600	12.5%	45.3	47.0

An intermediate multimodal accessibility cluster with values between 60 and 75, consists of Kavala (GR115), Blagoevgrad (BG413), Pazardzhik (BG423) and Kyustendil (BG415). The remaining NUTS3 areas of the Greece – Bulgaria CBA have significantly lower multimodal accessibility scores (<45).

Figure 49 presents the potential accessibility indices as related to the Greece – Bulgaria CBA average value. Two clusters are formed, the above average accessibility group consisting of Sofia stolitsa (BG411), Sofia (BG412), Pernik (BG414) followed by Blagoevgrad (BG413) and Kyustendil (BG415), and the remaining eastern, north-eastern and southern parts of the CBA with below average accessibility scores.

Figure 50 illustrates the index change in potential accessibility by air, during the period 2001-06. Again, although the Table 41 presented the change of the absolute values of the multimodal accessibility indices, this map type focuses on the change of the relative position of the regions within the EU27 space. 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. Three clusters occur. The first one appears composed by Rodopi (GR113), together with Yugozapaden (BG41) regional area, characterised by strong improvement in locational quality. Rodopi (GR113) and Kyustendil (BG415) improvement appears attributed to rail accessibility change, while for the remaining areas locational quality improvement is due to air accessibility change. Relatively intermediate improvement is seen in the remaining Yuzhen tsentralen (BG42) mostly attributed to rail and air accessibility changes. Finally, only Kardzhali (BG425) showed an opposite behaviour, due to negative change in road and rail accessibility indices and the limited air accessibility improvement.

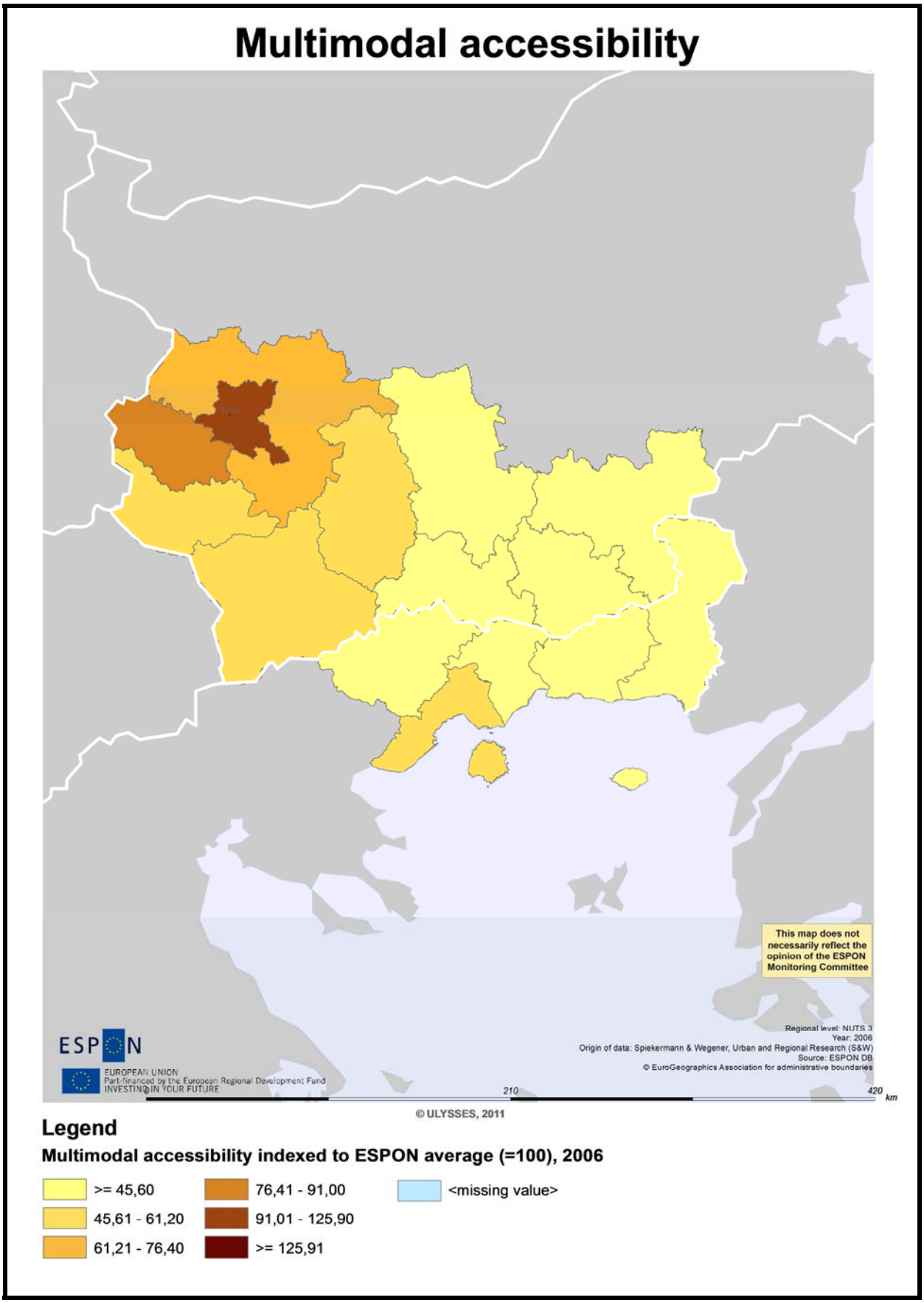

Figure 48. Multimodal Potential Accessibility Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on ESPON space average (=100), for year 2006.

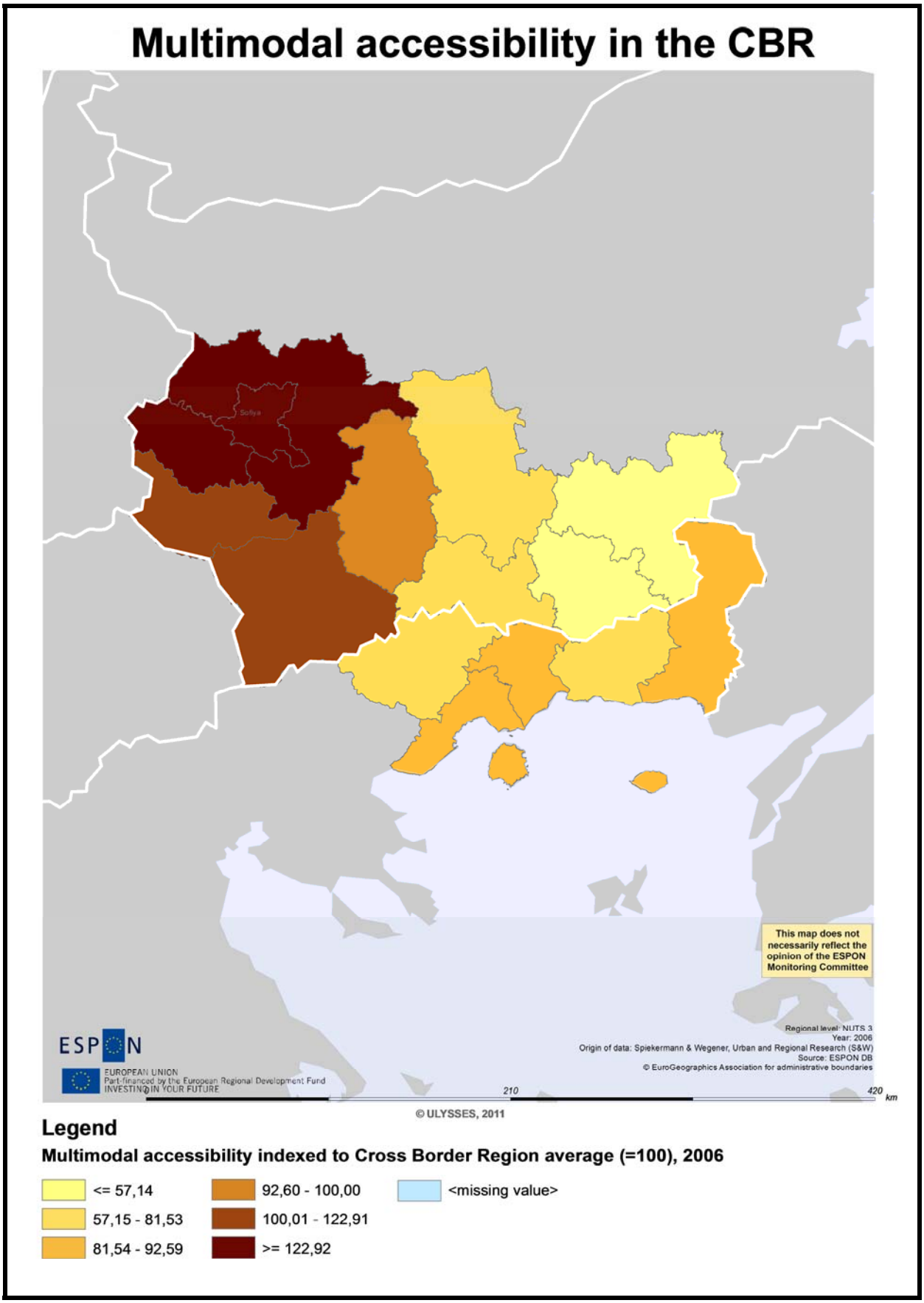

Figure 49. Multimodal Potential Accessibility Index of NUTS3 areas of the Greece – Bulgaria CBA, standardized on CBA space average (=100), for year 2006.

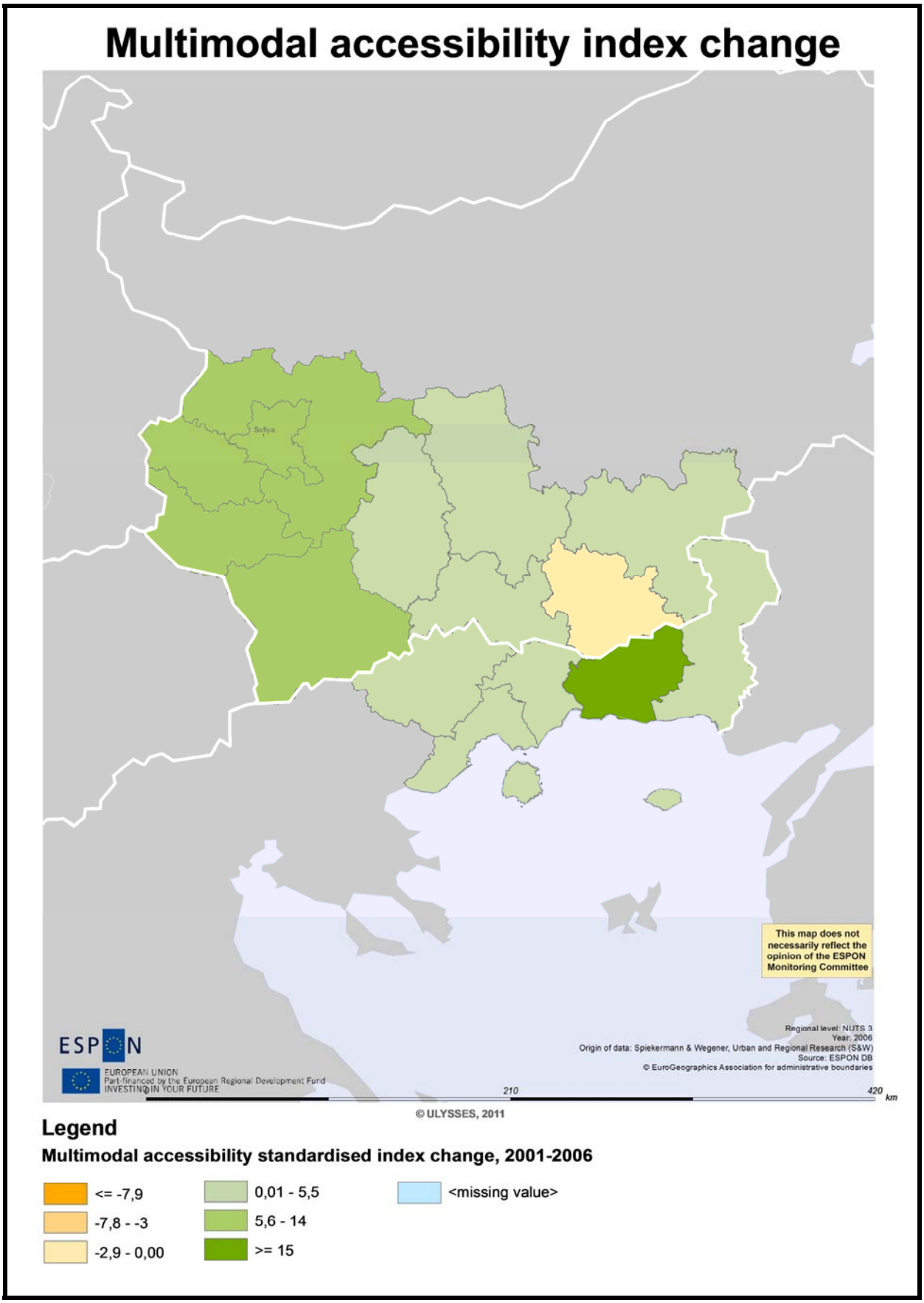

Figure 50. Standardized Index Change in Multimodal Potential Accessibility of the NUTS3 areas of the Greece – Bulgaria CBA, for the period 2001-2006.

5.6. Chapter Conclusions

- Accessibility and connectivity analysis was performed aiming to determine the general accessibility levels of the Greece – Bulgaria CBA according to the various transportation modes, i.e., road, rail and air, as well as multimodally. Comparisons were taken place between the index of each NUTS3 level unit and the ESPON and CBA average, and the change of the above indices through time was assessed.
- Results showed that the potential accessibility by road of Yugozapaden (BG41) and Yuzhen tsentralen (BG42) (34.38 and 32.56, respectively) appeared significantly higher than that of Anatoliki Makedonia, Thraki (GR11, 21.6). However, this latter area shows a strong improvement in the potential accessibility index between years 2001 and 2006 (from 18.5 to 21.6), due to infrastructure upgrading. Sofia stolitsa (BG411), Plovdiv (BG421) and Haskovo (BG422) present the higher potential accessibility by road indices, while Evros (GR111) and Drama (GR114) depict the lower values.
- The average potential accessibility by rail of Yugozapaden (BG41) appears slightly higher (18.88) than that of Yuzhen tsentralen (BG42, 16.62) and Anatoliki Makedonia, Thraki (GR11, 15.08). However, as before, the potential accessibility of Anatoliki Makedonia, Thraki shows significant improvement over time, compared to the other two areas. Sofia stolitsa (BG411) and Pernik (BG414) show the highest potential accessibility score, while Evros (GR111), Kardzhali (BG425) and Kyustendil (BG415) demonstrate the lower values.
- The average potential accessibility by air of Yugozapaden (BG41) appears significantly higher (82.54) than that of Anatoliki Makedonia, Thraki (GR11, 46.08) and Yuzhen tsentralen (BG42, 36.66). Moreover, the potential accessibility by air of Yugozapaden (BG41) shows significant improvement (mean 26.44%), in contrast to that of Yuzhen tsentralen (BG42, 17.72%) and Anatoliki Makedonia, Thraki (GR11, 11.58%). Sofia stolitsa (BG411) and Pernik (BG414) show the highest potential accessibility score, while Haskovo (BG422) and Kardzhali (BG425) depict the lower values.
- The average multimodal potential accessibility of Yugozapaden (BG41) appears significantly higher (74.1) than that of Anatoliki Makedonia, Thraki (GR11, 42.02) and Yuzhen tsentralen (BG42, 36.66). Moreover, the multimodal potential accessibility of Yugozapaden (BG41) shows significant improvement (mean 25.14%), in contrast to that of Yuzhen tsentralen (BG42, 13.86%) and Anatoliki Makedonia, Thraki (GR11, 11.70%). Sofia stolitsa (BG411), Sofia (BG412) and Pernik (BG414) show the highest multimodal potential accessibility score, while Haskovo (BG422) and Kardzhali (BG425) depict the lower values.
- The temporal variability analysis indicated that Rodopi (GR113) and Kyustendil (BG415) experienced strong accessibility improvement, mostly attributed to rail accessibility upgrade; while for the remaining Yugozapaden

areas (BG41) locational quality improvement is due to air accessibility change. Relatively intermediate improvement is seen in the remaining Yuzhen tsentralen (BG42), mostly attributed to rail and air accessibility changes. Finally, only Kardzhali (BG425) showed an opposite behaviour, due to negative change in road and rail accessibility indices and the limited air accessibility improvement.

Chapter 6 – Gothenburg & Lisbon/Europe 2020 Strategy Analysis

6.1. Aims, Indicators and Methods

The territorial dimension of European policy is highlighted in the new document "Gothenburg and Lisbon/Europe 2020: New European strategy" (2010) approved by the European Commission. The aim of this strategy is to help Europe to come out stronger from the crisis and turn the EU into a smart, sustainable and inclusive economy delivering high levels of employment, productivity and social cohesion. Europe 2020 sets out a vision of Europe's social market economy for the 21st century. This strategy sets priorities and specifically, one of them claims for the territorial cohesion:

- Smart growth: developing an economy based on knowledge and innovation,
- Sustainable growth: promoting a more resource efficient, greener and more competitive economy,
- Inclusive growth: fostering a high-employment economy delivering social and territorial cohesion.

The integral objectives of the Lisbon and Gothenburg Strategies are leading towards:

- an economy based on knowledge and innovation;
- investments in human capital;
- social models opposing social exclusion, poverty and ageing;
- territorial governance models focused on environment preservation and public health as opportunities of sustainable development;
- an economic policy focused on trans-frontier cooperation.

As appropriate to the 'conventional and formal' feeling of the Lisbon/Gothenburg process, a strategic set of indicators to measure the progress of the agenda has been agreed upon between the European Commission and the European Council. Based upon this list, the study of the territorial performance of the Greece – Bulgaria Cross-Border Area was considered. The list of indicators is covering a wide domain of five most important sectors, as economic background and growth, employment, research and innovation, economic reform, social cohesion and the environment.

The indicators considered for the economy and employment analysis, the research and innovation analysis, the social cohesion analysis and the environmental analysis are shown in Table 44.

Table 44. Set of indicators for the Territorial Performance Analysis concerning the Gothenburg and Lisbon/Europe 2020 Strategy.

Theme	Variable	Geographical Scale	Source	Timeframe
Economy & Employment Analysis	GDP in million euro	NUTS3	EUROSTAT	1997-2009
	GDP per inhabitant	NUTS3	EUROSTAT	1997-2009
	GDP in PPP	NUTS3	EUROSTAT	1997-2009
	Employment by NACE	NUTS3	EUROSTAT	1997-2008
	GVA by NACE	NUTS3	EUROSTAT	1997-2008
Research & Innovation Analysis	Population by age groups and educational level	NUTS3	EUROSTAT	1999-2009
	Employment in medium and high tech manufacturing	NUTS2	ESPON DB (Regional Innovation Scoreboard)	2004
	EPO Patents by per million of inhabitants	NUTS2	EUROSTAT	2007
	Gross Domestic Expenditure in R&D (GERD)	NUTS2	EUROSTAT	2007
	Business Enterprise Expenditure in R&D (BERD)	NUTS2	EUROSTAT	2007
	Higher Education Expenditure in R&D (HERD)	NUTS2	EUROSTAT	2007
Social Cohesion Analysis	Population at Risk of Poverty	NUTS2	EUROSTAT	2008
	Infant Mortality	NUTS2	EUROSTAT	1997-2007
	Persons aged 25-64 with tertiary education	NUTS2	EUROSTAT	2008-2010
	Youth Unemployment	NUTS3	EUROSTAT	1999-2010
	Long-term Unemployment	NUTS2	EUROSTAT	1999-2009
Environmental Analysis	Ozone Concentration Exceedances	NUTS3	EUROSTAT	2008
	Soil Sealing Area	NUTS3	5th Cohesion Report	2006
	Solar Energy Resources	NUTS3	5th Cohesion Report	1981-1990
	NATURA 2000 Area	NUTS3	5th Cohesion Report	2009
	Wind Energy Resources	NUTS3	5th Cohesion Report	2000-2005

6.2. Economy & Employment Analysis

5.2.1. Gross Domestic Product

The total GDP of the Greece – Bulgaria CBA is in 2008 35.4 billion euros. Yogozapaden (BG41, 16.3 billion euros) represents approximately 46.2% of this GDP, Anatoliki Makedonia, Thraki (GR11, 9,0 billion euros) represents the 25.5% while Yuzhen tsentralen (BG42, 4.9 billion euros) represents almost 14.1% of the CBA. At the same time, Yogozapaden (BG41) represents almost half the Bulgarian GDP (46.3%), Yuzhen tsentralen (BG42) the 14% of the national Bulgarian GDP, while Anatoliki Makedonia, Thraki (GR11) represents only 3.8% of the Greek GDP.

Over the years studied, Sofia stolitsa (BG411), Pernik (BG414) and Smolyan (BG424) depicted the higher annual mean change in GDP, with values of 19.32%, 17.36% and 13.94%, respectively. Significantly slower GDP growth was reported for the Anatoliki Makedonia, Thraki area (5.13%) and its NUTS3 regions, as Kavala (GR115, 4.44%), Evros (GR111, 4.88%). The Greece – Bulgaria CBA shows a strong mean annual GDP growth of 10.9%.

Table 46 presents the temporal change in GDP per inhabitant at current market prices for the NUTS3 areas of the Greece – Bulgaria CBA. In 2008 Anatoliki Makedonia, Thraki (GR11) shows the higher per inhabitant GDP (14,900 euros), significantly higher than that of Yugozapaden (BG41, 7,800 euros) and Yuzhen tsentralen (BG42, 3,200 euros). The high GDP per inhabitant of Yugozapaden appears attributed to that of Sofia stolitsa (BG411, 10,700 euros), while the rest NUTS3 areas have 30-50% lower values. The deviation of the NUTS3 areas from mean GDP per inhabitant value in Anatoliki Makedonia, Thraki (GR11) and Yuzhen tsentralen (BG42) appears very low. The GDP per inhabitant at current market prices of the Greece – Bulgaria CBA in 2008 reaches the order of 8,600 euros.

To understand better regional disparities in the GDP per capita per of the various NUTS regions throughout the Greece – Bulgaria CBA, the coefficient of deviation (CDev) was used. This indicator was obtained by calculating the ration of the standard deviation to the mean, and therefore it serves as a proper index for comparing the distribution of geographical units, which differ greatly on their average. As a reference, the coefficient of deviation was considered for the countries of which the CBA is part as well as for the whole NUTS3 and NUTS0 of the ESPON space (EU7+CH+NO for the N0 and only EU7 for NUTS 0).

Figure 51 illustrates the temporal variability in the coefficient of deviation of the above defined regions. It occurs that Greece shows limited and slowly decreasing regional disparity (CDev 2008: 21.2). Bulgaria on the contrary depicts a strong increasing trend, mostly attributed to the very rapid change of GDP per inhabitant in Sofia stolitsa, as related to the rest of the country (CDev 2008: 44.3). The CBA shows significant regional disparity, with a rapidly converging to ESPON NUTS0 and NUTS3 trend (CDev 2008: 72.3).

Table 45. Temporal Variability of GDP (million euros) in each NUTS3 region of the Greece – Bulgaria CBA.

NUTS Name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bulgaria	9,219	11,386	12,429	14,035	15,552	17,027	18,374	20,388	23,256	26,477	30,772	35,431
Yugozapaden	2,905	3,811	4,476	4,858	5,715	6,549	7,184	8,168	9,453	11,422	14,053	16,394
Sofia (stolitsa)	1,951	2,667	3,272	3,491	4,257	4,947	5,389	6,133	7,245	8,994	11,324	13,296
Sofia	275	357	362	442	446	508	565	660	769	934	977	920
Blagoevgrad	354	387	413	447	492	527	620	717	764	787	928	1,046
Pernik	139	170	177	203	222	259	256	316	330	346	417	716
Kyustendil	186	231	252	275	298	308	354	341	344	360	407	416
Yuzhen tsentralen	1,594	1,825	1,933	2,189	2,420	2,561	2,846	3,186	3,599	4,010	4,470	4,999
Plovdiv	758	858	902	1,043	1,175	1,243	1,386	1,561	1,818	1,991	2,247	2,456
Haskovo	271	304	329	372	416	432	474	518	547	569	654	751
Pazardzhik	291	330	354	372	381	426	470	534	597	786	838	906
Smolyan	112	146	165	186	232	239	243	269	296	316	359	455
Kardzhali	161	187	183	216	215	221	272	304	342	349	372	431
Greece	119,937	121,985	131,936	137,929	146,428	156,615	172,431	185,266	194,819	211,300	227,074	236,917
Anatoliki Makedonia, Thraki	5,264	5,328	5,790	5,716	6,220	6,293	6,987	7,412	7,863	8,033	8,801	9,054
Evros	1,426	1,448	1,549	1,598	1,608	1,653	1,925	1,956	2,096	2,115	2,434	2,370
Xanthi	892	929	975	984	1,097	1,040	1,213	1,301	1,362	1,442	1,561	1,583
Rodopi	802	803	903	912	1,194	1,165	1,194	1,251	1,295	1,363	1,502	1,514
Drama	782	794	846	905	954	990	1,102	1,233	1,258	1,254	1,324	1,442
Kavala	1,362	1,354	1,516	1,316	1,367	1,446	1,553	1,672	1,852	1,859	1,980	2,145
CBA Total	**11,356**	**12,790**	**14,131**	**14,951**	**16,774**	**17,965**	**19,862**	**21,952**	**24,514**	**27,475**	**31,794**	**35,446**

Table 46. Temporal Variability of GDP per inhabitant (euros) in each NUTS3 region of the Greece – Bulgaria CBA.

NUTS Name	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Bulgaria	1,100	1,400	1,500	1,700	2,000	2,200	2,400	2,600	3,000	3,400	4,000	4,700
Yugozapaden	1,400	1,800	2,100	2,300	2,700	3,100	3,400	3,900	4,500	5,400	6,700	7,800
Sofia (stolitsa)	1,600	2,200	2,700	2,900	3,600	4,200	4,500	5,100	5,900	7,300	9,200	10,700
Sofia	1,000	1,300	1,400	1,700	1,600	1,900	2,100	2,500	3,000	3,600	3,800	3,600
Blagoevgrad	1,000	1,100	1,200	1,300	1,400	1,600	1,900	2,100	2,300	2,400	2,800	3,200
Pernik	900	1,100	1,100	1,300	1,500	1,800	1,800	2,200	2,300	2,500	3,000	5,200
Kyustendil	1,100	1,300	1,500	1,600	1,800	1,900	2,200	2,200	2,200	2,400	2,700	2,800
Yuzhen tsentralen	900	1,100	1,100	1,300	1,500	1,600	1,800	2,000	2,300	2,600	2,900	3,200
Plovdiv	1,000	1,200	1,200	1,400	1,600	1,700	2,000	2,200	2,600	2,800	3,200	3,500
Haskovo	900	1,100	1,100	1,300	1,500	1,600	1,800	1,900	2,100	2,200	2,500	2,900
Pazardzhik	900	1,000	1,100	1,200	1,200	1,400	1,500	1,800	2,000	2,700	2,800	3,100
Smolyan	700	1,000	1,100	1,300	1,700	1,700	1,800	2,000	2,200	2,400	2,800	3,600
Kardzhali	800	900	900	1,100	1,300	1,400	1,700	1,900	2,200	2,200	2,400	2,800
Greece	11,100	11,300	12,100	12,600	13,400	14,300	15,600	16,700	17,500	19,000	20,300	21,100
Anatoliki Makedonia, Thraki	8,800	8,900	9,600	9,400	10,200	10,400	11,500	12,200	12,900	13,200	14,500	14,900
Evros	9,600	9,800	10,400	10,700	10,800	11,100	12,900	13,100	14,100	14,200	16,300	15,900
Xanthi	8,800	9,200	9,600	9,600	10,600	10,000	11,700	12,400	13,000	13,600	14,700	14,800
Rodopi	7,400	7,300	8,200	8,200	10,800	10,500	10,800	11,300	11,700	12,300	13,500	13,600
Drama	7,700	7,900	8,300	8,900	9,400	9,700	10,800	12,200	12,500	12,400	13,200	14,400
Kavala	9,700	9,600	10,700	9,300	9,700	10,300	11,000	11,900	13,100	13,300	14,100	15,300
CBA Mean	**3,700**	**3,900**	**4,300**	**4,300**	**4,800**	**5,000**	**5,500**	**6,000**	**6,500**	**7,100**	**8,000**	**8,600**

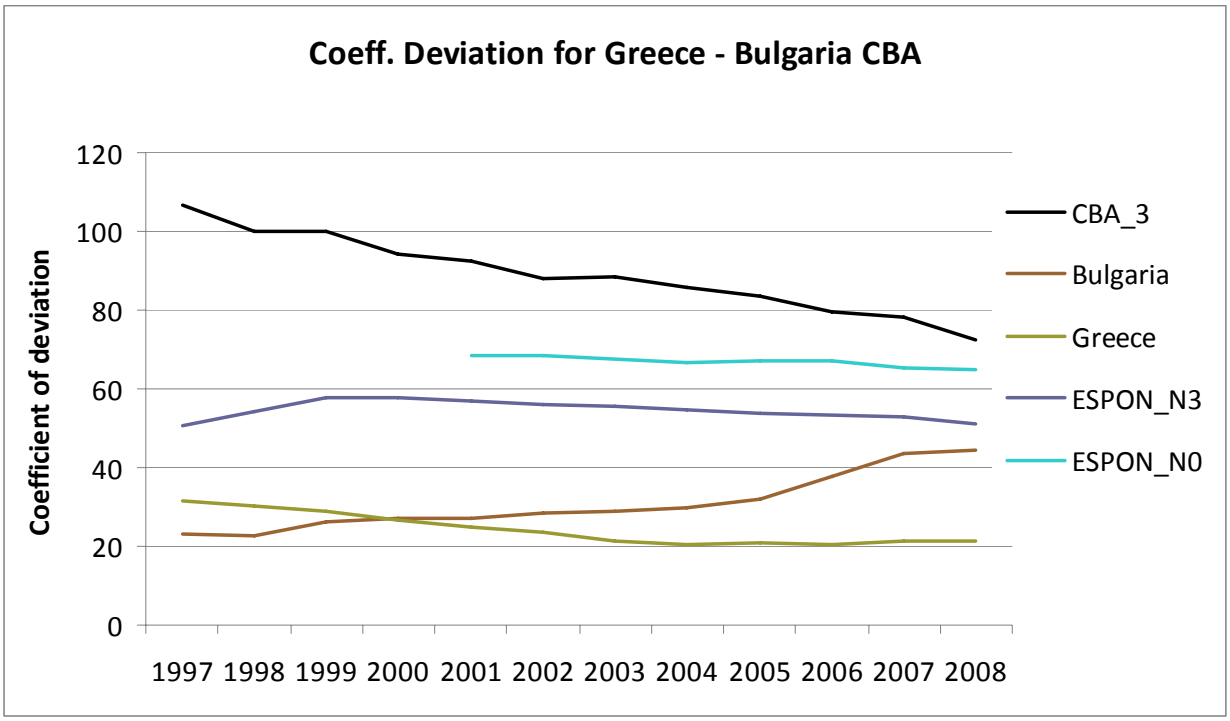

Figure 51. Temporal variability of Coefficient of Deviation for the NUTS3 areas of the Greece – Bulgaria CBA, the NUTS0 areas and the ESPON NUTS0 and NUTS3 space (EU27+CH+NO for the N0 and only EU27 for NUTS 0).

The GDP per inhabitant data for the period 1997 – 2008 were used for the catching up analysis of the NUTS3 areas of the Greece – Bulgaria CBA. This analysis involves two comparative procedures, performed at a NUTS III level:

1. Comparison of each NUTS3 area with the CBA leader, in terms of GDP per inhabitant, using the index number analysis;
2. Establishing the performance of each NUTS3 area in relation to the leading region, using a logistic function, thus aiming to explore the notion of territorial catching-up.

For both analyses, the value of reference for GDP per inhabitant would be the highest value among all NUTS3, pertaining to the Inner London West region. However, at this territorial level, GDP per inhabitant may 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 exists a steady flow of migrant workers, as well as commuters from other NUTS3 areas, leading to serious overestimations in the derived GDP per capita of the economic centre. For that reason, instead of simply considering the GDP per capita of the Inner London West NUTS3, the whole Greater London NUTS2 was used as a reference for this analysis.

For the first analysis, the indexing of each NUTS3 area's GDP per inhabitant to that of the leading region for year 2008, the following expression was used:

$$Index\,GDP_{NUTS3\,Region} = \left(\frac{GDP_{NUTS3\,Region}}{GDP_{Leading\,Region}} \right) \times 100$$

For the second analysis, the speed of convergence (or catching-up) to the leading regions was evaluated through the standard logistic process. In the present analysis, the catching-up process sets the relative position of each NUTS3 area and its relative trajectory up to the level of 95% of the GDP per inhabitant of the leading region within the next 50 years. The difference of performance of each region in comparison to the leading region is measured as the years needed to reach the level assumed above. The logistic function is of the form:

$$X = 0.95\,\bar{X} = \frac{\bar{X}}{1 + ke^{-\alpha t}}$$

Where k is a logistic coefficient and t is the time needed for GDP convergence. All regions with a performance at the level of 95% or higher, when compared to the leading region, were also considered as leading regions. This analysis distinguishes GDP per capita 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 NUTS2 area. Fast converging regions have a growth rate which allows them to reach the leader in less than 20 years, steady catching-up regions could reach the leader 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. Based on the above the following notation was established:

leading region	>=95% (GPD already close to the leader)
fast converging region	Convergence in a period 0 to 20 years
steady catching-up region	Convergence in a period 20 to 50 years
slow catching-up region	Convergence in a period 50 to 100 years
slow converging region	Convergence in a period 100 to 250 years
non converging region	Convergence in a period > 250 years
diverging region	growth (g) <<< growth London (g*)

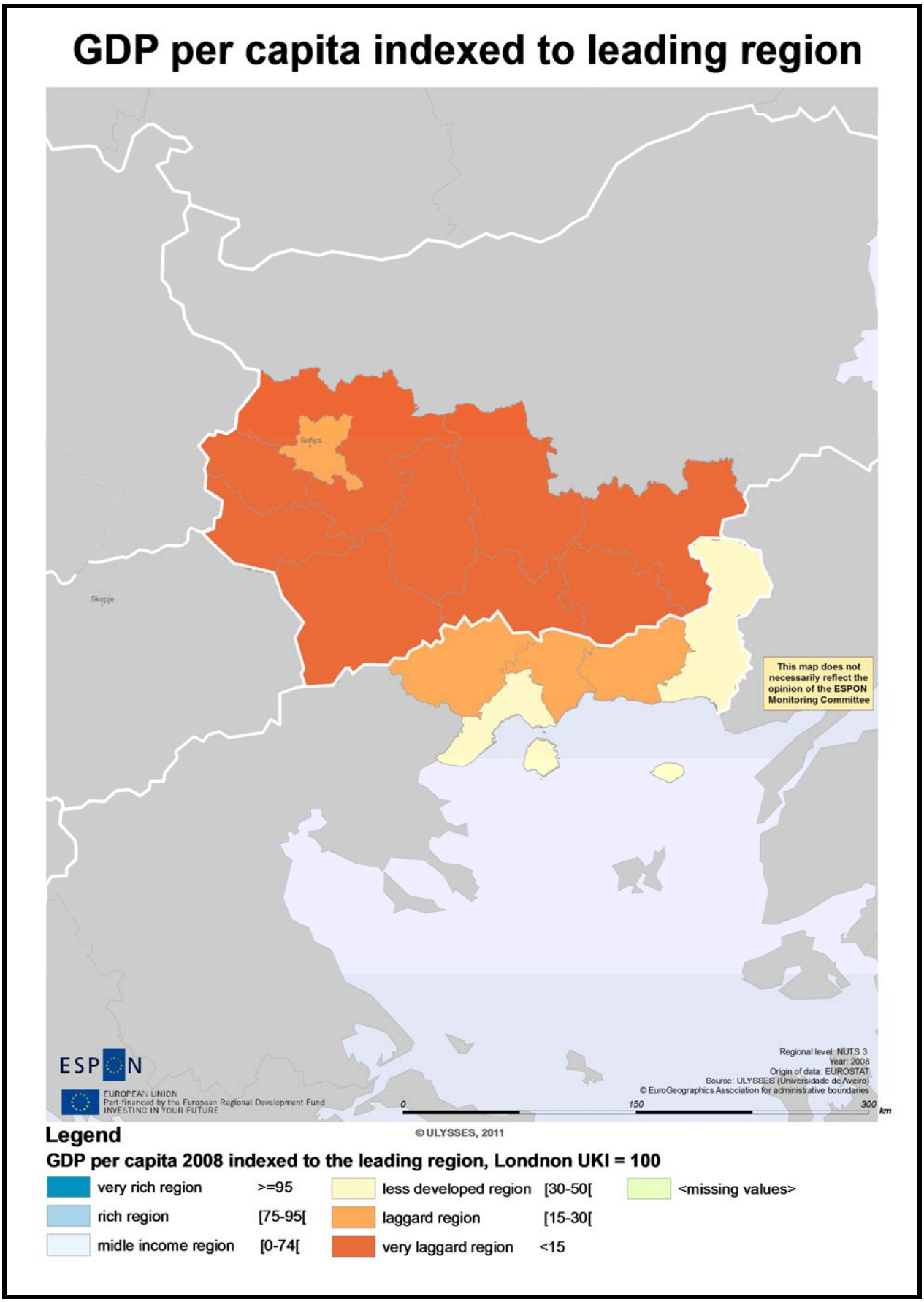

Figure 52. GDP per inhabitant (2008) of the NUTS3 areas of the Greece – Bulgaria CBA, indexed to the EU leading region (London NUTS2).

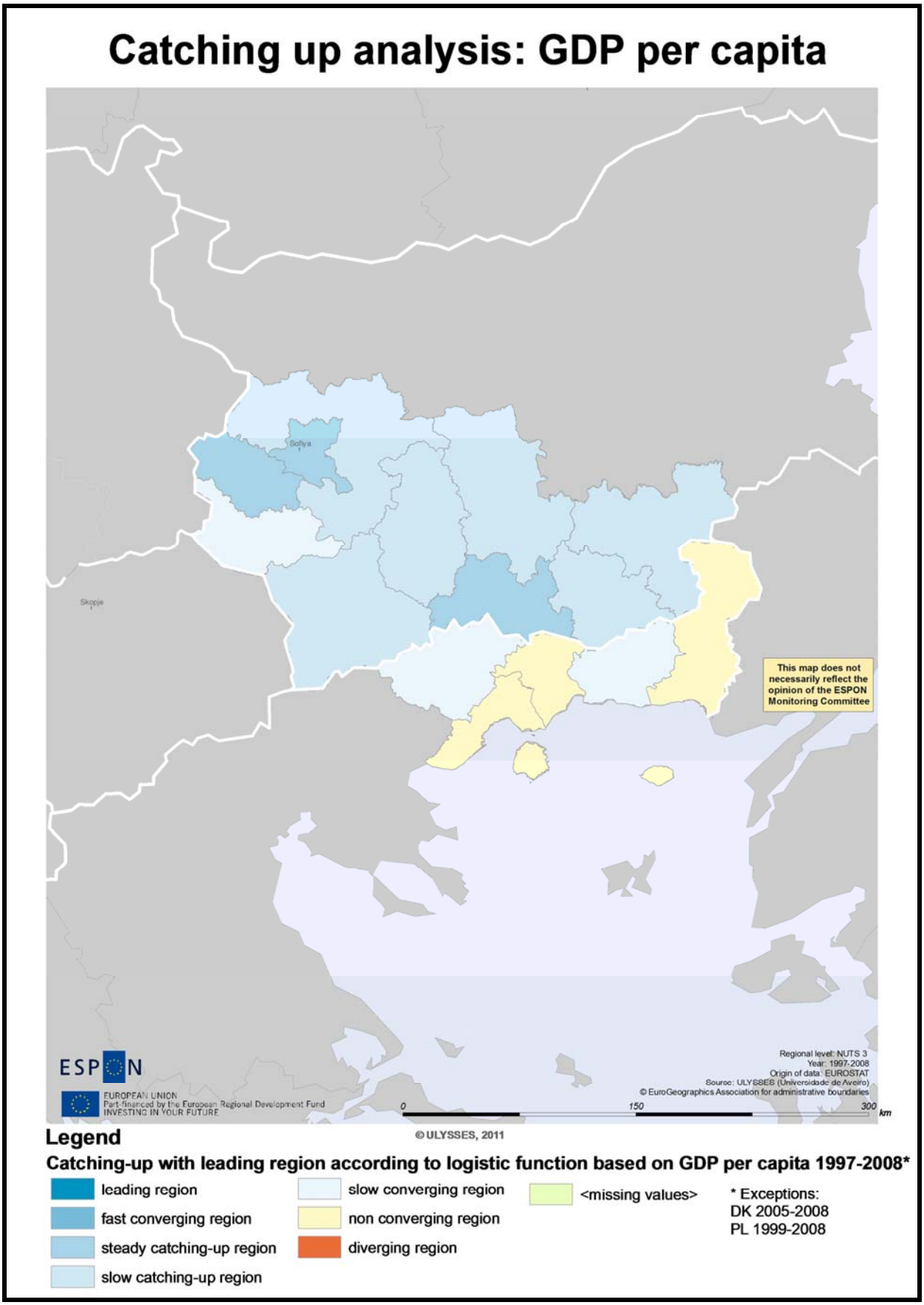

Figure 53. Convergence with the EU leading region (London NUTS2), based on the GDP per inhabitant of the NUTS3 areas of the Greece – Bulgaria CBA.

Table 47. GDP per inhabitant convergence analysis for each NUTS3 region of the Greece – Bulgaria CBA.

NUTS Name	Annual GDP per capita Growth Rate	Relative to the Leader Growth Rate	Relative Position (k)	Coefficient (α)	Years to catch-up the Leader	NUTS3 Region Class
Sofia (stolitsa)	18.86%	14.07%	3.73	0.178	23.8	steady catching-up region
Sofia	12.35%	7.83%	13.06	0.084	65.4	slow catching-up region
Blagoevgrad	11.15%	6.68%	14.81	0.071	79.1	slow catching-up region
Pernik	17.29%	12.57%	8.73	0.140	36.4	steady catching-up region
Kyustendil	8.86%	4.48%	17.07	0.047	121.8	slow converging region
Plovdiv	12.06%	7.55%	13.46	0.081	68.3	slow catching-up region
Haskovo	11.22%	6.75%	16.45	0.072	80.2	slow catching-up region
Pazardzhik	11.90%	7.39%	15.32	0.079	72.0	slow catching-up region
Smolyan	16.05%	11.38%	13.06	0.123	45.0	steady catching-up region
Kardzhali	12.06%	7.55%	17.07	0.080	72.3	slow catching-up region
Evros	4.69%	0.48%	2.18	0.007	533.2	non converging region
Xanthi	4.84%	0.62%	2.42	0.009	437.4	non converging region
Rodopi	5.69%	1.43%	2.72	0.020	201.1	slow converging region
Drama	5.86%	1.59%	2.51	0.022	173.4	slow converging region
Kavala	4.23%	0.03%	2.31	0.000	7,751.8	non converging region

It occurs that based on the indexed GDP per inhabitant analysis, the Greece – Bulgaria CBA is considered as less developed to very laggard region, having NUTS3 areas with index ranging between 30-50, 15-30 or even below 15, as compared to Greater London NUTS2 (indexed as 100). More specifically, the whole Bulgarian NUTS3 areas are falling in this latter category, while only Sofia stolitsa (BG 411) and Drama (GR114), Xanthi (GR112) and Rodopi (GR113) are considered as laggard regions. Evros (GR111) and Kavala (GR115) score higher in this indexed GDP per inhabitant analysis, clustered as 'less developed regions', having indices of 31.42 and 30.24, respectively.

The results of the catching-up analysis are presented in Figure 53 and Table 47. The leading region of EU27, Greater London NUTS2 region, shows an annual growth rate of 4.2%, during the 1997-2008 period. The trend in GDP per inhabitant during the examined period in the Greece – Bulgaria CBA, shows that three NUTS3 areas (Kavala (GR115), Xanthi (GR112) and Evros (GR111)) have quite similar to the leading region trends. These areas are therefore considered as non-converging regions to the Greater London NUTS2 GDP per inhabitant. Kyustendil (BG415), Rodopi (GR113) and Drama (GR114) are considered as 'slow converging areas', while Sofia stolitsa (BG411), Pernik (BG414) and Smolyan (BG424) having GDP per inhabitant annual growth rates almost 3-4 times higher than the leading region, are considered as 'steady catching-up areas'. However, as most NUTS3 areas have GDP annual growth rates approximately double to the leading region, they are considered as 'slow catching-up regions'.

6.2.2. Employment by NACE

Eurostat has adopted NACE classification list to categorize data related to the various economic activities of each NUTS area. Based on this list, employment in the various NACE economic activities was examined for the NUTS3 areas of the Greece – Bulgaria CBA. Employment was examined considering the first level NACE economic sectors: a) Agriculture, Forestry & Fishing (sectors A – B), b) Industry (except construction, sectors C - E), c) Construction (sector F), d) Wholesale and Retail Trade, Tourism and Transport (sectors G – I), e) Financial Intermediation and Real Estate (sectors J – K), and f) Public Administration and Community Services (sectors L – P).

The share of employment in year 2008, based on the first level NACE economic activities, in all NUTS3 areas of the Greece – Bulgaria CBA is presented in Figure 54. It occurs that employment in the CBA is distributed rather evenly among economic activities as Agriculture, Forestry & Fishing (23.52%), Wholesale and Retail Trade, Tourism and Transport (22.13%), Public Administration and Community Services (21.41%) and Industry (except Construction) (20.86%). The remaining sectors as Construction (6.94%) and Wholesale and Retail Trade, Tourism and Transport (4.87%) show a limited contribution in CBA's employment. On the contrary, employment in Bulgaria is not uniformly distributed, with sectors

as Wholesale and Retail Trade, Tourism and Transport (24.39%) and Industry (except Construction) (21.49%) having the largest share. In Greece employment seems distributed among Wholesale and Retail Trade, Tourism and Transport (32.39%) and Public Administration and Community Services (26.67%).

In terms of the independent NACE categories, the highest employment rate in Agriculture, Forestry & Fishing is found in Rodopi (GR113, 44.57%), Kardzhali (BG425, 36.36%) and Haskovo (BG422, 32.72%). The highest employment shares in Industry were found in Kyustendil (BG415, 32.84), Blagoevgrad (BG413, 32.24%) and Pernik (BG414, 30.32%). Evros (GR111, 7.58%) and Kavala (GR115, 9.42%) have the lowest shares in this category. Smolyan (BG424, 10.10%) shows the highest employment percentage in Construction, followed by Sofia stolitsa (BG411, 9.45%) and Pernik (BG414, 9.25%). In the Wholesale and Retail Trade, Tourism and Transport sector, Kavala (BG115, 36.35%) and Sofia stolitsa (BG411, 32.72%) show the highest employment rates. In the Financial Intermediation and Real Estate sector the highest employment shares are shown in Sofia stolitsa (BG411, 19.74%), while in Public Administration and Community Services sector, Evros (GR111, 37.73%) and Xanthi (BG112, 31.29%) are leading.

In terms of the annual growth rate of employment in the period 2000-2008, the Greece – Bulgaria CBA showed a slight employment increase (+0.73%) in all NACE sectors. This increase is mostly fuelled by the strong employment rise in Construction (+6.32%) and the Financial Intermediation and Real Estate sector (+4.05%). The only sector depicting employment reduction during the above defined period is Agriculture, Forestry & Fishing (-1.19%). The Wholesale and Retail Trade, Tourism and Transport sector and the Public Administration and Community Services sector showed only modest increase (+2.09% and +1.02%, respectively). A marginal increase of 0.19% was shown in the annual employment rate of the Industry sector.

Increase in the annual employment growth rate was lower in the Greece – Bulgaria CBA than that shown by Greece (+1.50%) and Bulgaria (+2.10%). In Bulgaria, the highest positive employment rate was shown in Construction sector (+10.58%), followed by the Financial Intermediation and Real Estate sector (+8.15%). In Greece, the highest employment growth rate was shown in the Financial Intermediation and Real Estate sector (+5.74%), followed by Construction (+3.03%). Agriculture, Forestry and Fishing depicted a sharp employment decline of -3.55%.

Examining the mean temporal change of employment in all NUTS3 areas of the Greece – Bulgaria CBA, it occurs that Agriculture, Forestry and Fishing showed the higher losses, especially in Pazardzhik (BG423, -11.5%). Kardzhali (BG425) showed positive growth in this sector (+5.87%). In the Industry sector, employment illustrated the higher positive annual rates in Rodopi (GR113, +4.73%) and Smolyan (BG424, +3.35%), while the highest negative rates were shown in Kavala (GR115, -6.09%) and Drama (GR114, -5.31%).

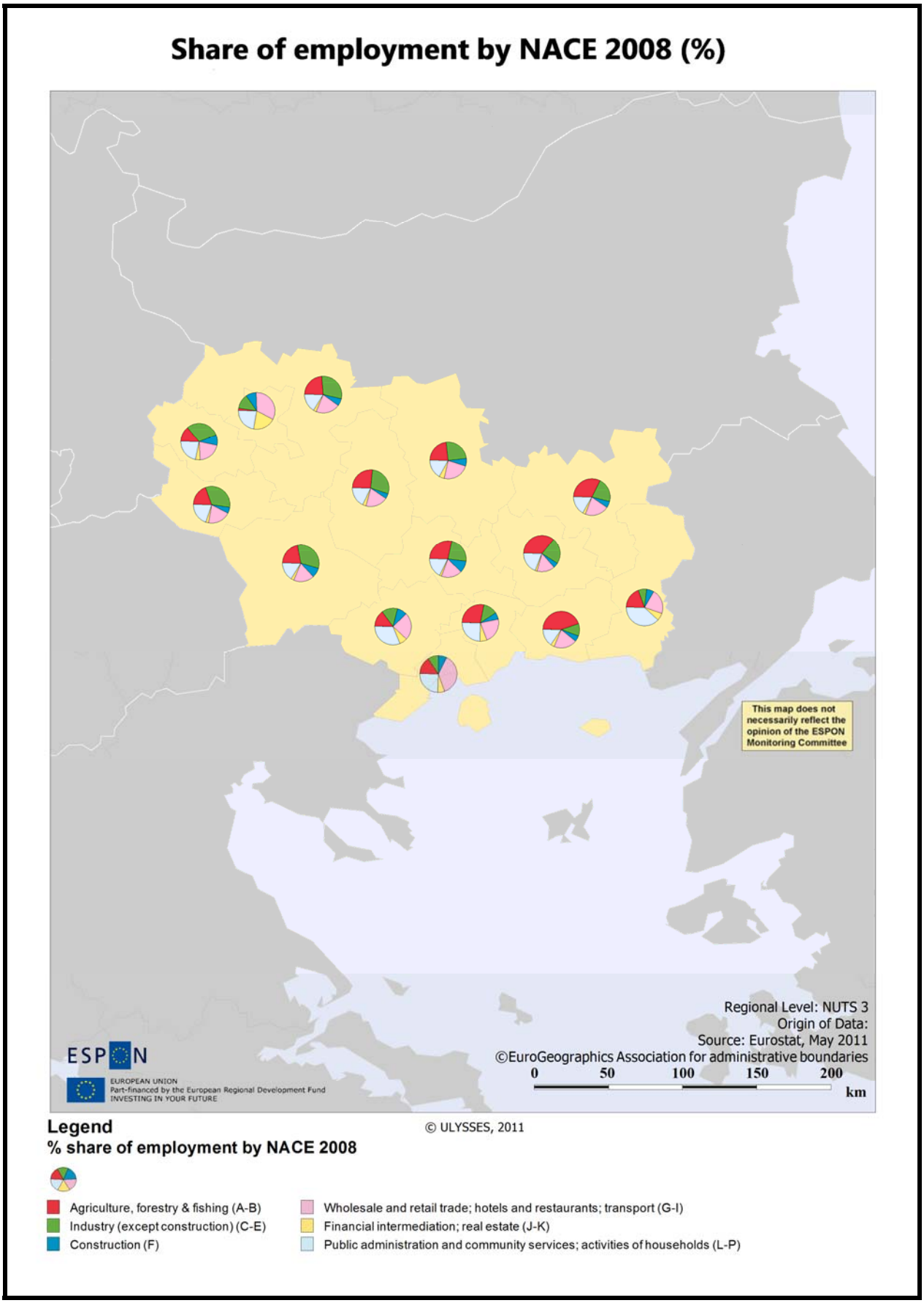

Figure 54. Share of employment by NACE in year 2008 for the NUTS3 areas of the Greece – Bulgaria CBA.

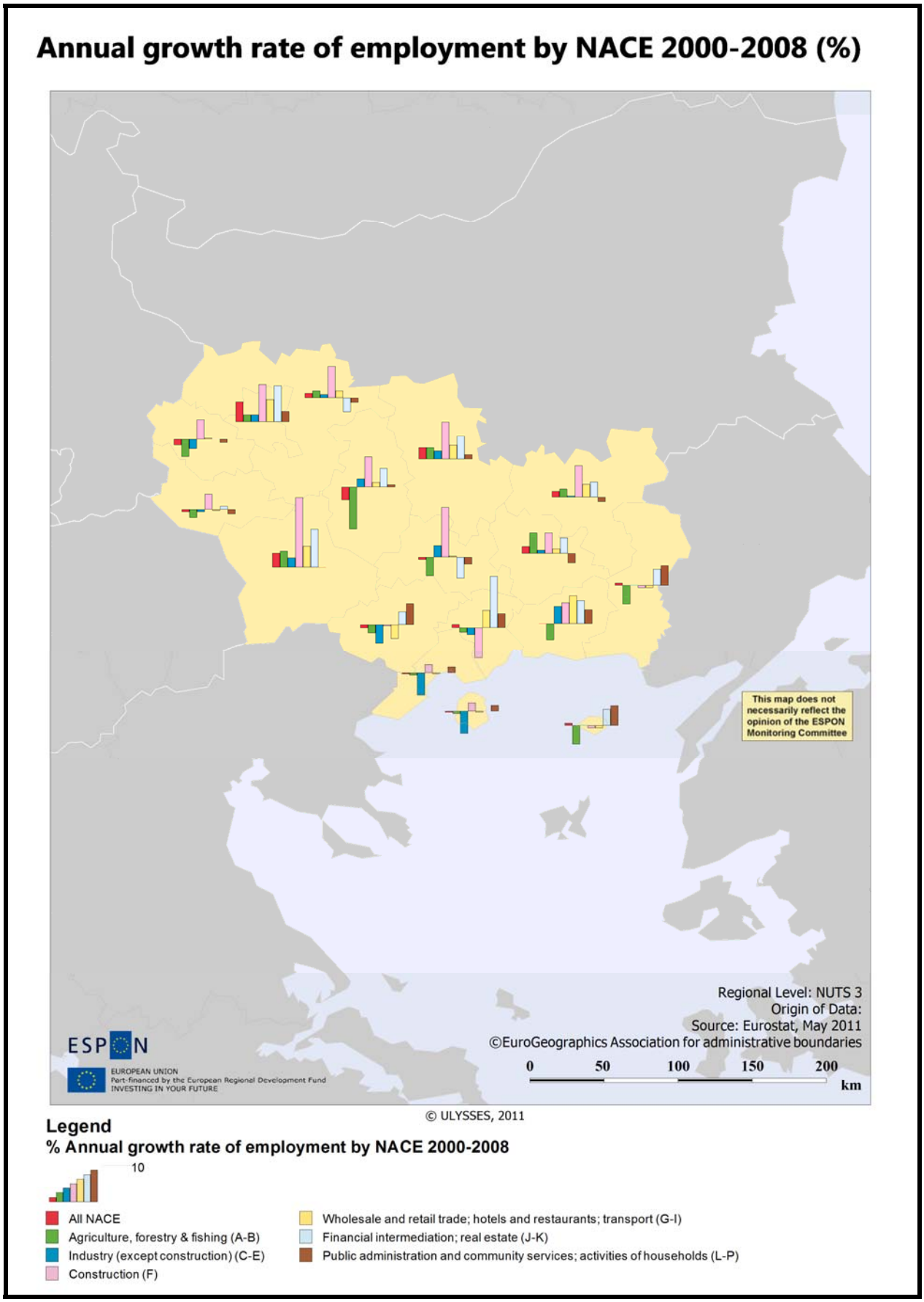

Figure 55. Annual growth rate of employment by NACE for the period 2000-2008 in the NUTS3 areas of the Greece – Bulgaria CBA.

The highest employment annual growth rate is observed in Blagoevgrad (BG413, 19.46%), followed by Smolyan (BG424, 13.94%). All NUTS3 areas of the CBA depicted positive growth rates in Construction, apart of Drama (GR114, -0.47%) and Evros (GR111, -0.57%). The Wholesale and Retail Trade, Tourism and Transport sector showed the higher positive annual growth rate in employment in Rodopi (GR113, +7.83%) and Sofia stolitsa (BG411, +6.17%). Significant reduction in this sector is seen in Drama (GR114, -4.00%). Xanthi (GR112, +14.18%), Blagoevgrad (BG413, +10.75%) and Sofia stolitsa (BG411, +10.00%) showed the highest increase in employment of all NUTS3 areas in the Financial Intermediation and Real Estate sector. Finally, Drama (GR114, +5.71%) and Evros (GR111, +5.44%) showed the higher positive rate in the Public Administration and Community Services employment.

6.2.3. Gross Value Added by NACE

The GVA of the Greece – Bulgaria CBA in year 2008 from all NACE categories was 25.8 billion euro. The corresponding value for year 1997 was only 9.5 billion euro, representing an increase of 169%. The 2008 GVA is attributed by 5.1% to Agriculture, Forestry and Fishing Sector, by 17.9% to Industry (except Construction), by 8.1% to Construction, by 26.8% to Wholesale and Retail Trade, Tourism and Transport sector, by 23.4% to the Financial Intermediation and Real Estate sector and by 18.6% to the Public Administration and Community Services sector (Figure 56).

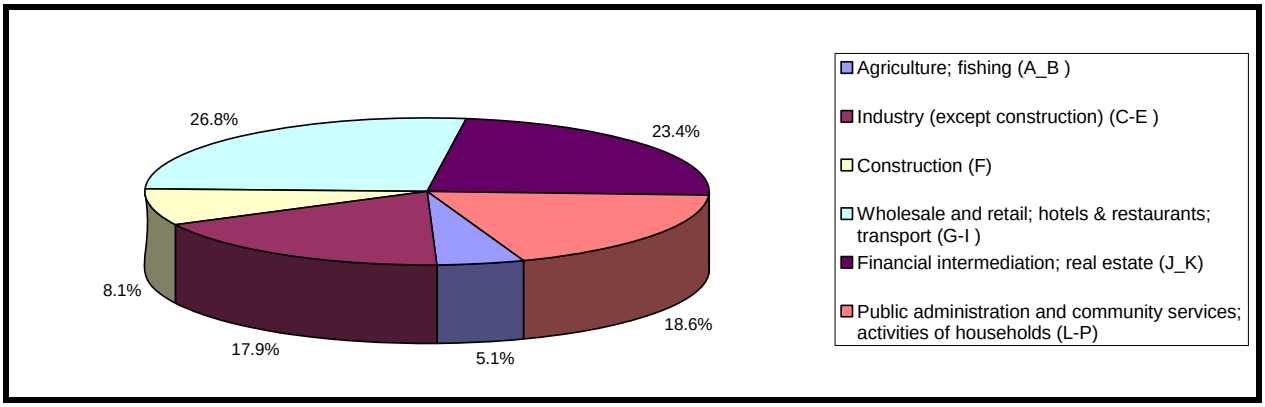

Figure 56. Share first level NACE sectors in the Gross Value Added of the Greece – Bulgaria CBA.

This CBA Gross Value Added represents approximately the 87.5% of the Bulgarian GVA but only 12.3% of the Greek GVA. The relative highest share in the produced GVA by Agriculture, Forestry and Fishing is produced in Kardzhali (BG425, 31.71%) and Blagoevgrad (BG413, 15.49%). The highest GVA share from Industry is produced in Pernik (BG414, 60.98%), while the higher relative GVA produced by Construction is observed in Smolyan (BG424, 17.85%) and Blagoevgrad (BG413,

11.81%). Wholesales and Retail Trade, Tourism and Transport sector shows the higher share in Sofia stolitsa (BG411, 34.49%) and Rodopi (GR113, 32.46%). The Financial Intermediation and Real Estate sector produces a rather well distributed among NUTS3 areas GVA, ranging between 14-17%. Finally, the Public Administration and Community Services sector produces the higher relative GVA in Anatoliki Makedonia, Thraki (GR11, 28.05%).

The temporal change of NACE participation in the produced GVA of the Greece – Bulgaria CBA for years 1997 and 2008 is shown in Figure 57. A significant reduction of 16% in the produced GVA from Agriculture, Forestry and Fishing is observed. This GVA is mostly dispersed to the Industry (1.26%), Construction (1.61%) and Public Administration sectors (3.62%).

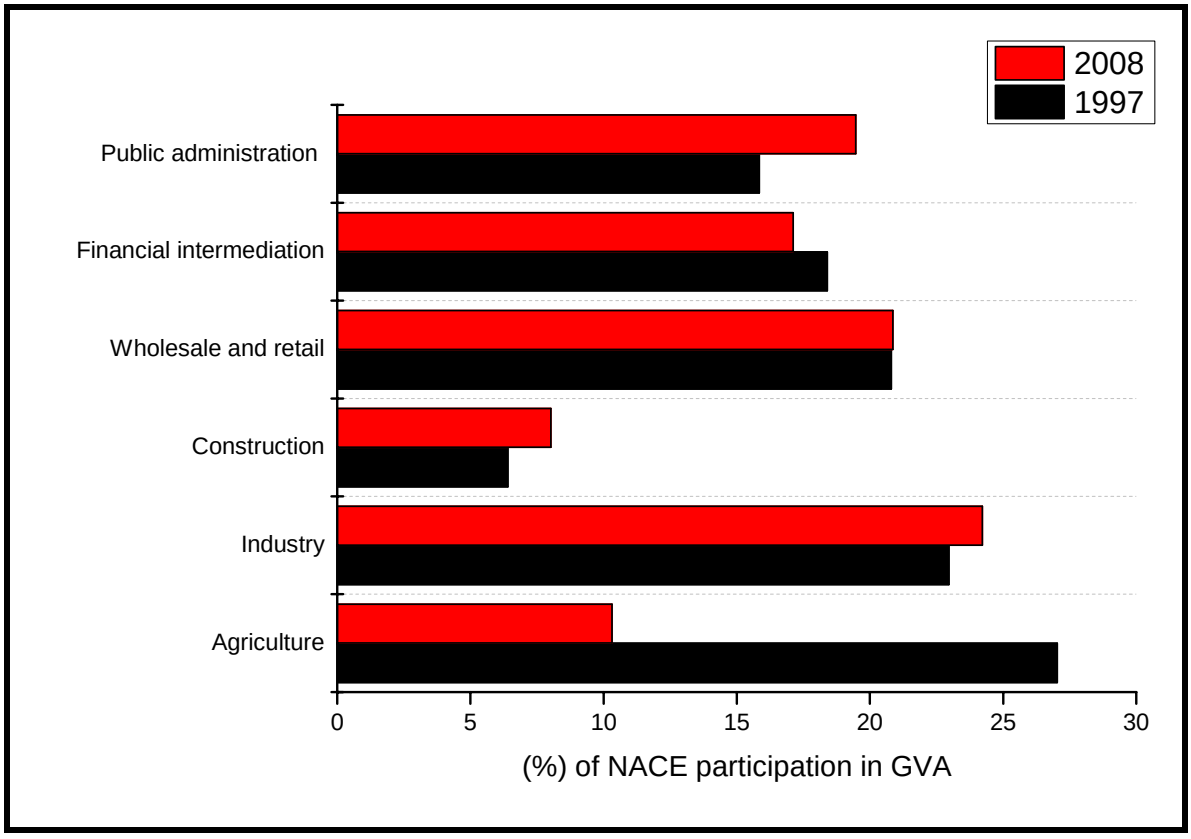

Figure 57. Percentage of NACE participation in the produced GVA of the Greece – Bulgaria CBA for years 1997 and 2008.

In Yugozapaden (BG41) the produced GVA by all NACE sectors increased in the period 1997 – 2008 by 437% (from 2.5 billion euro to 13.6 billion euro). Agriculture's contribution to total GVA shrank significantly by almost 15% within the 1997 – 2008 period. In this region, Industry, Construction and Public Administration increased their shares by 6.98%, 4.25% and 3.63%, respectively (Figure 58).

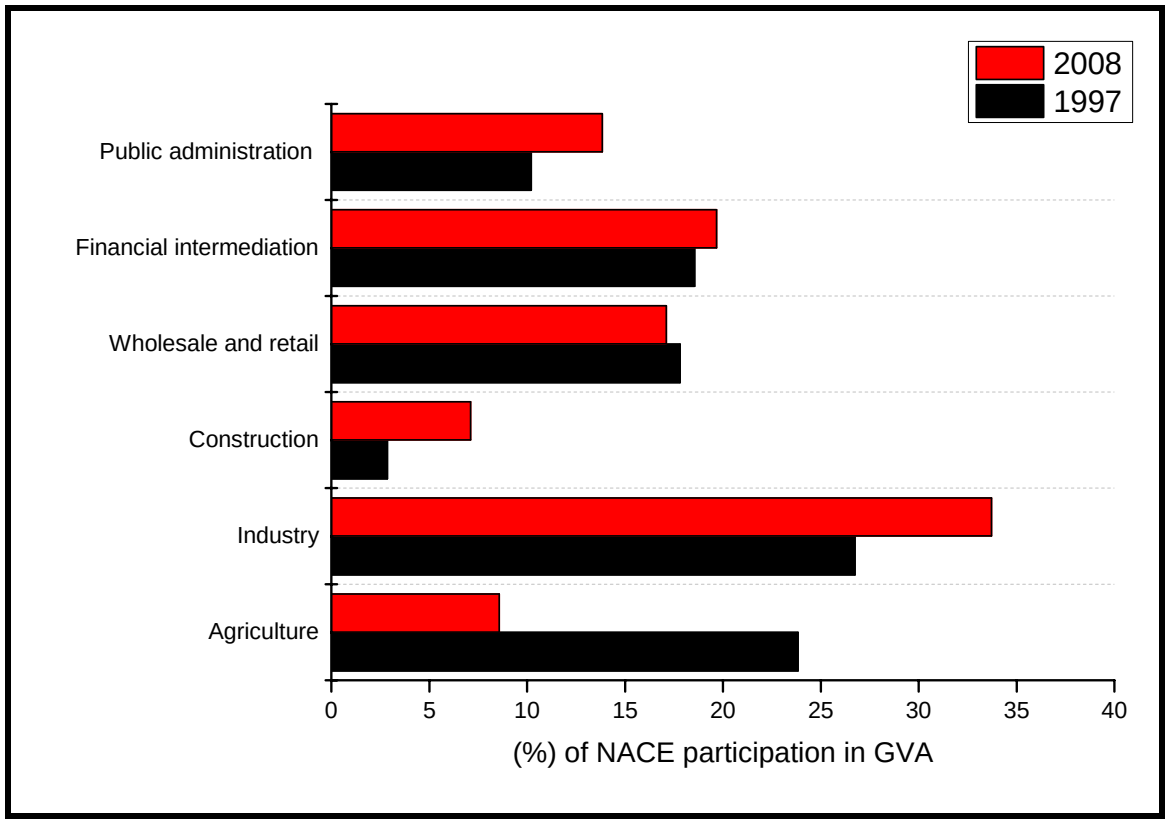

Figure 58. Percentage of NACE participation in the produced GVA of Yugozapaden (BG41) for years 1997 and 2008.

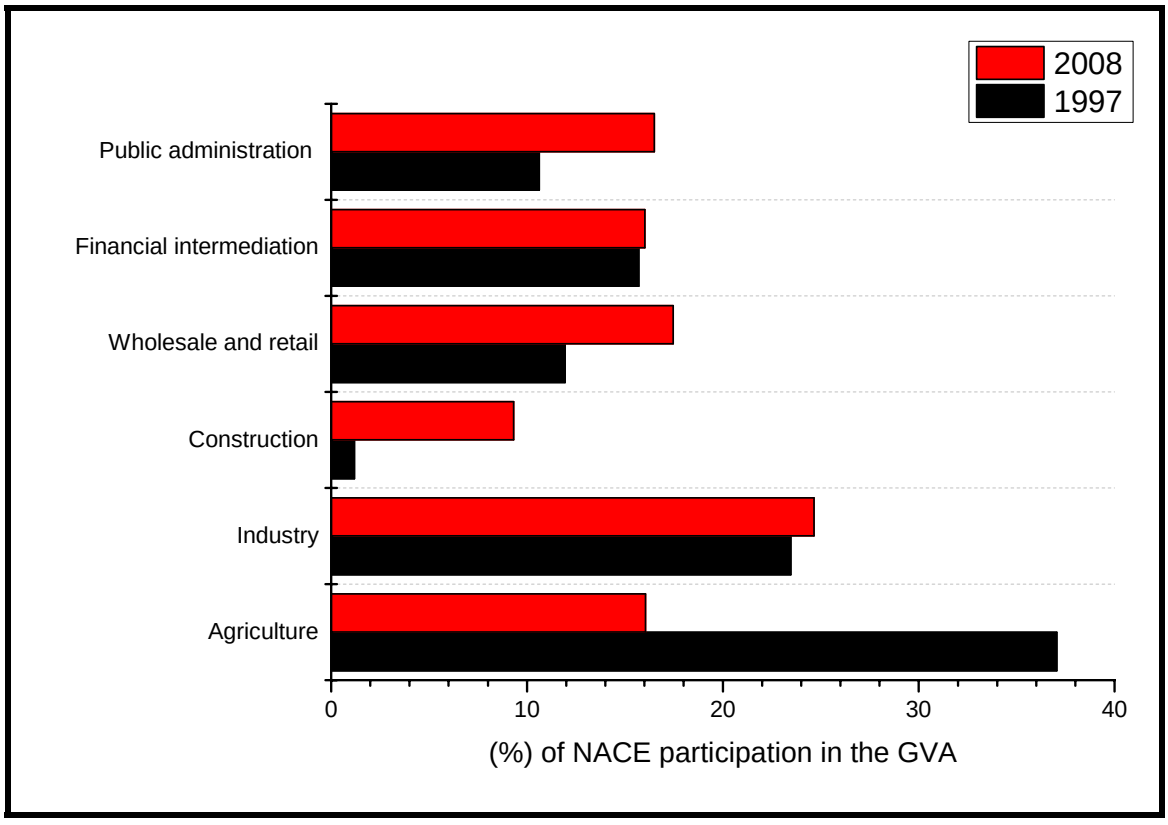

Figure 59. Percentage of NACE participation in the produced GVA of Yuzhen tsentralen (BG42) for years 1997 and 2008.

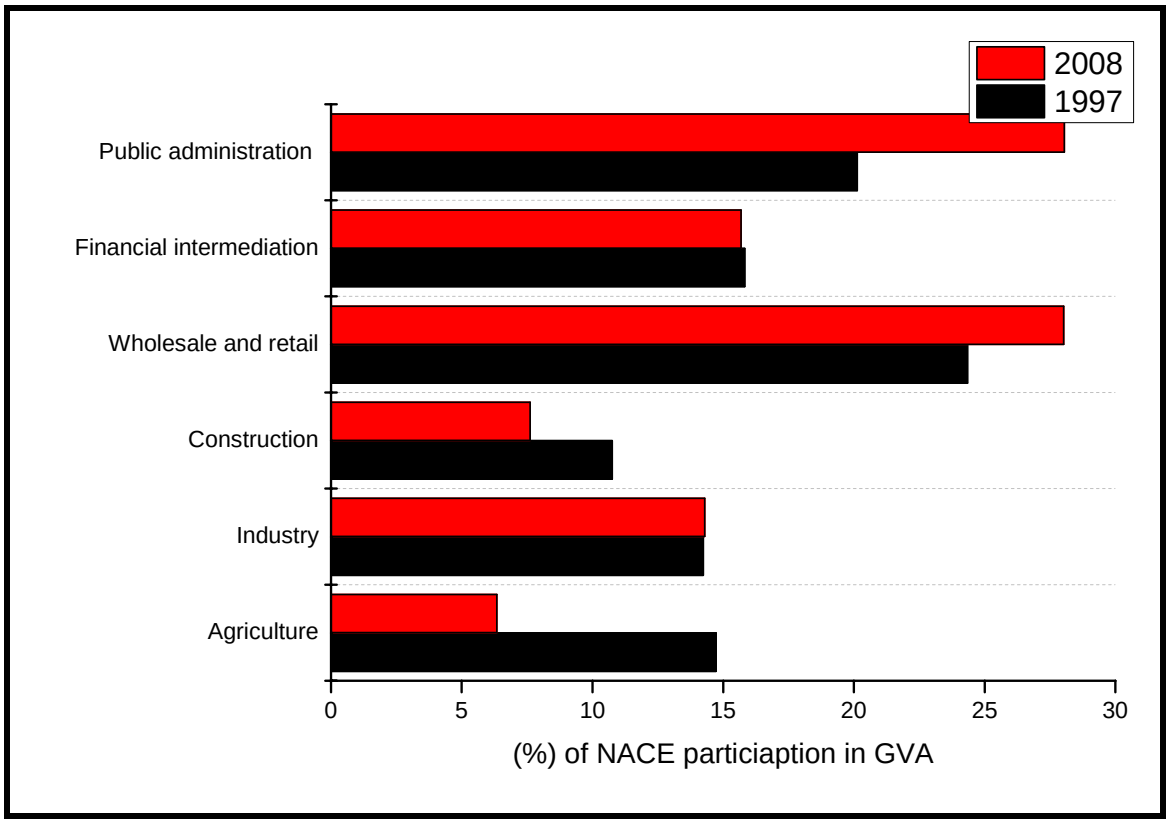

Figure 60. Percentage of NACE participation in the produced GVA of Anatoliki Makedonia, Thraki (GR11) for years 1997 and 2008.

In Yuzhen tsentralen (BG42) the GVA increased by 198% during the examined period (from 1.3 billion euro to 4.1 billion euro). The reduction in Agriculture's participation in area's GVA, between 1997 and 2008, reaches 21%. Construction, Wholesale and Retail and Public Administration sectors increased their relative contribution by 8.14%, 5.51% and 5.87%, respectively (Figure 59).

In Anatoliki Makedonia, Thraki (GR11) the GVA produced by all NACE sectors increased by 42% during the 1997 – 2008 period (from 5.6 billion euro in 1997 to 8.0 billion euro in 2008). An 8% decrease in Agricultural GVA is seen during the 1997 – 2008 period, followed by a 3.1% drop in the Construction sector. The sectors of Wholesale and Retail (by 3.67%) and Public Administration sectors (by 7.93%) increased their relative contribution in the produced GVA of the region (Figure 60).

6.3. Social Cohesion Analysis

Social cohesion is the capacity of a society to ensure the welfare of all its members, minimising disparities and avoiding polarisation (Council of Europe, 2004). It a fact that presently Europe faces a number of potential threats, setting social cohesion into significant risk. The fight against social exclusion is one of the EU's social policy goals, and the aim is to significantly reduce the number of persons at risk of poverty and social exclusion by 2020.

The selected indicators for this analysis are:

- Unemployment Rate, i.e., the number of unemployed persons as a percentage of the labor force (the total number of people employed plus unemployed),
- Long-term Unemployment Rate, i.e., the percentage of unemployed persons (12 months and more), aged at least 15 years who are available to start work within the next two weeks and who are seeking work,
- Youth Unemployment Rate, i.e., the percentage of the unemployed in the age group 15 to 24 years old, compared to the total labour force (both employed and unemployed) in that age group. However, it should be remembered that a large share of people between these ages are outside the labour market (since many youths are studying full time and thus are not available for work), which explains why youth unemployment rates are generally higher than overall unemployment rates, or those of other age groups,
- Population at Risk of Poverty, after social transfers, i.e., the at-risk-of-poverty rate expressing the share of the population below a defined poverty line (and therefore likely to suffer social exclusion) according to the equivalised disposable income. This population is defined by the adjusted for each household size and composition income of less than 60% of national median value (European Commission's 5th Cohesion Report Database).
- Infant Mortality Rate, the number of deaths of infants under one year old per 1,000 live births.
- Population aged between 25-64 with tertiary education, including tertiary programmes with academic orientation (type A) which are largely theoretical and tertiary programmes with an occupational orientation (type B).

Statistical data on the social cohesion indicators at NUTS3 level for the Greece – Bulgaria CBA do not exist. Therefore, this analysis will be limited to the available NUTS2 or even NUTS1 data available for the examined region. Furthermore, the available statistical data for each selected parameter refer to variable time periods, ranging between 2008 and 2010.

Table 48. Social Cohesion indicators at NUTS2 level of the Greece – Bulgaria CBA.

NUTS Name	Unemployment Rate (2010)	Long-term Unemployment Rate (2009)	Youth Unemployment Rate (2010)	Population at Risk of Poverty (2008)	Infant Mortality Rate (2008)	Population with Tertiary Education (2010)
EU27	9.6 %	3.0 %	20.9 %	17.0 %	4.3 %	25.9 %
Bulgaria	10.2 %	3.0 %	23.2 %	21.4 %	8.6 %	23.2 %
Yugozapaden	6.8 %	1.4 %	15.2 %	12.2 %	6.4 %	33.1 %
Yuzhen tsentralen	11.4 %	2.8 %	31.8 %	22.6 %	9.2 %	19.0 %
Greece	12.5 %	3.9 %	32.9 %	20.1 %	2.7 %	23.9 %
Anatoliki Makedonia, Thraki	14.2 %	5.4 %	40.7 %	25.4 %	4.7 %	18.4 %
CBA Mean	**10.80 %**	**3.20 %**	**29.23 %**	**20.07 %**	**6.77 %**	**23.50 %**

Results of social cohesion indices for the NUTS0 and 2 of the Greece – Bulgaria CBA and the EU27 are shown in Table 48. Overall, CBA mean value of unemployment rate for year 2010 (10.8%) appears slightly higher than the mean EU27 value (9.6%), mostly due to the higher unemployment in Anatoliki Makedonia, Thraki (GR11, 14.2%) and Yuzhen tsentralen (BG42, 11.4%). A similar behaviour is seen in the Long-term Unemployment index, with a mean CBA value of 3.20% and a mean EU27 value of 3.0%. Long-term Unemployment in Anatoliki Makedonia, Thraki (GR11) appears approximately two and four times higher than that in Yuzhen tsentralen (BG42) and Yugozapaden (BG41), respectively. A significant deviation is recorded in Youth Unemployment Rate of the CBA (29.2%) as compared to EU27 index of 20.9%. Again Youth Unemployment appears extremely high in Anatoliki Makedonia, Thraki (GR11, 40.7%) and Yuzhen tsentralen (BG42, 31.8%) in relation to Yugozapaden (BG41, 15.2%).

A similar behaviour was shown in the Population at Risk of Poverty Index, reaching 20% in the Greece – Bulgaria CBA, as compared to the mean EU27 value of 17%. Again, significant degradation is shown in Anatoliki Makedonia, Thraki (GR11, 25.4%) and Yuzhen tsentralen (BG42, 22.6%). Infant Mortality showed a relatively moderate deviation of mean CBA value (6.7%) compared to the correspondent EU27 (4.3%), with Yugozapaden (BG41, 6.4%) and Yuzhen tsentralen (BG42, 9.2%) depicting values above CBA's mean level. Greece shows an Infant Mortality rate (2.7%) well beyond the EU27 mean value. Anatoliki Makedonia, Thraki (GR11) and Yuzhen tsentralen (BG42) have significantly lower than the corresponding national averages Tertiary Education rates. The CBA shows low disparity to the corresponding EU27 value.

The temporal change of social cohesion indicators for the period 1999 - 2011 is shown in Figure 61. In all NUTS0 and 2 areas of the Greece – Bulgaria CBA, total unemployment shows a general decreasing trend in the period 1999 – 2008, from a mean CBA value of 10.9% to that of 5.6%. After 2008 a sharp unemployment rise is observed, returning back to the level of 10.8% for the CBA. A similar behaviour is also depicted by youth unemployment variability, as in 1999 the mean CBA youth unemployment was at the level of 23.8%, decreasing gradually to 12.7% in 2008 and exceeding within two years the previous levels (29.3% in 2010). Long-term unemployment of the CBA (data up to 2009) showed a reduction from 6.6% in 2003 to 2.9% in 2008 and a slight rise to 3.2% in 2009.

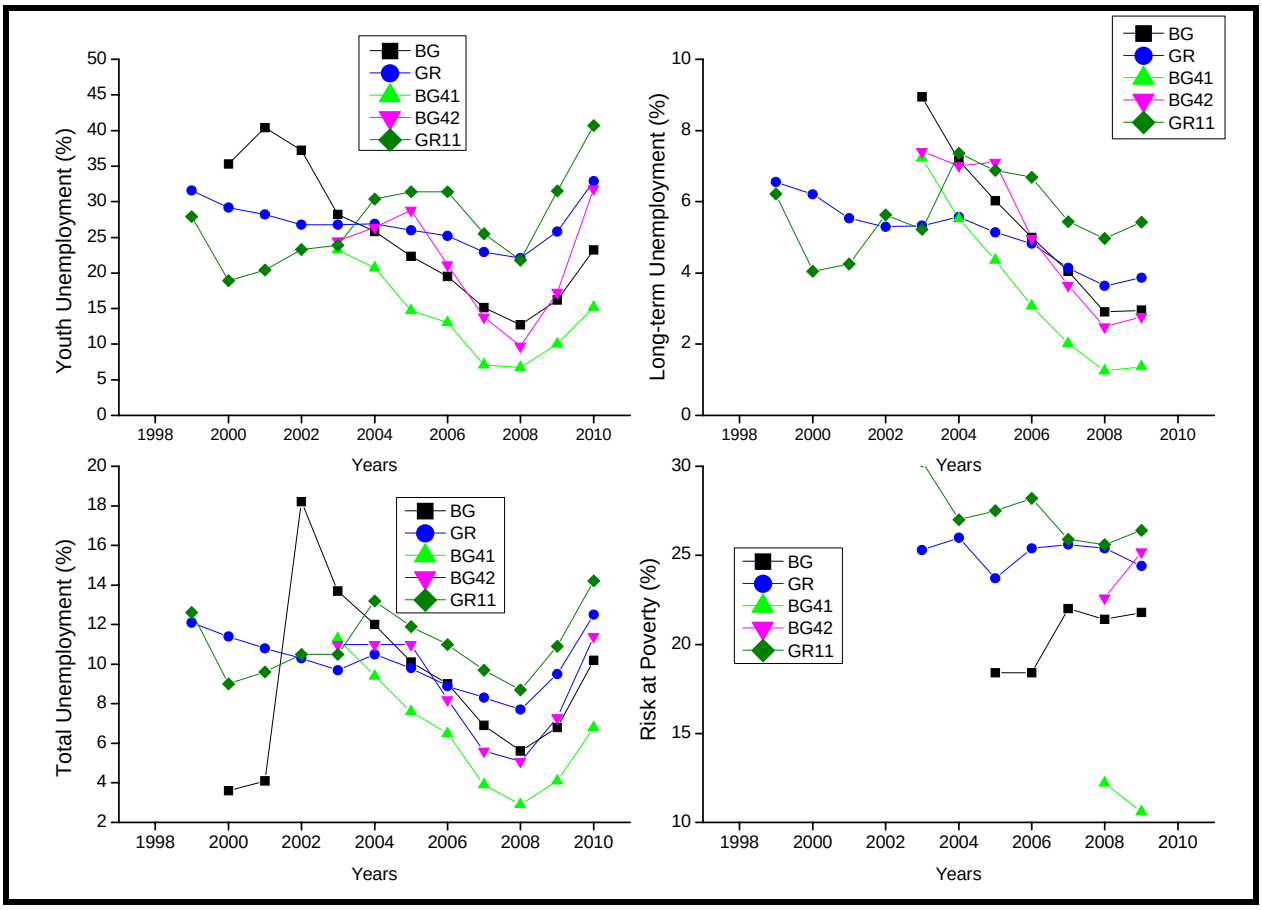

Figure 61. Temporal variability of Social Cohesion Indicators for the NUTS0 and 2 areas of the Greece – Bulgaria CBA.

6.4. Chapter conclusions

- The territorial performance of the Greece – Bulgaria CBA according to the Lisbon/Gothenburg indicators was examined, focusing on the sectors of economic growth, employment, research and innovation, economic reform, social cohesion and the environment.
- Economic and employment analysis considered indices as the GDP, the GDP per capita, the GDP coefficient of deviation and their temporal trends, leading towards an indexing and convergence analysis for the NUTS3 areas of the CBA, compared to the leading in terms of economic performance region (London NUTS2 area).
- It occurs that based on the indexed GDP per inhabitant analysis, the Greece – Bulgaria CBA is considered as less developed to very laggard region, having NUTS3 areas with index ranging between 30-50, 15-30 or even below 15, as compared to Greater London NUTS2 (indexed as 100). The whole Bulgarian NUTS3 areas are falling in this latter category, while only Sofia stolitsa (BG 411) and Drama (GR114), Xanthi (GR112) and Rodopi (GR113) are considered as laggard regions. Evros (GR111) and Kavala (GR115) score relatively higher, thus clustered as 'less developed regions', having indices of 31.42 and 30.24, respectively.
- On the other hand, convergence analysis revealed that Kavala (GR115), Xanthi (GR112) and Evros (GR111) have quite similar to the leading region GDP per inhabitant trends, implying that these areas are non-converging. Kyustendil (BG415), Rodopi (GR113) and Drama (GR114) are considered as 'slow converging areas', while Sofia stolitsa (BG411), Pernik (BG414) and Smolyan (BG424) having GDP per inhabitant annual growth rates almost 3-4 times higher than the leading region, are considered as 'steady catching-up areas'.
- Employment analysis revealed that employment in the CBA is distributed rather evenly among NACE economic activities, with a slight employment annual increase (+0.73%) over the last decade. This increase is mostly fuelled by the strong employment rise in Construction (+6.32%) and the Financial Intermediation and Real Estate sector (+4.05%). Strong employment reduction during the latest decade is seen in Agriculture, Forestry & Fishing sector (-1.19%). The highest employment annual growth rate in the NUTS3 areas is observed in Blagoevgrad (BG413, 19.46%), followed by Smolyan (BG424, 13.94%).
- The GVA of the Greece – Bulgaria CBA in year 2008 from all NACE categories was 25.8 billion euro, increased over the latest decade by 169%. This GVA is mostly attributed to the Wholesale and Retail Trade, Tourism and Transport sector (26.8%) and to the Financial Intermediation and Real Estate sector (23.4%). The temporal change of GVA over the last decade indicated that the primary sector reduced its contribution by 16%, while

construction and public administration increased their share by 1.3 and 3.6%, respectively.

- Social cohesion indicators, available only at NUTS0 and 2 level units, illustrated that the CBA mean unemployment rate for year 2010 (10.8%) appears slightly higher than the mean EU27 value (9.6%), mostly due to the higher unemployment in Anatoliki Makedonia, Thraki (GR11, 14.2%) and Yuzhen tsentralen (BG42, 11.4%). Similarly, Long-term Unemployment in Anatoliki Makedonia, Thraki (GR11) appeared approximately two and four times higher than that in Yuzhen tsentralen (BG42) and Yugozapaden (BG41), respectively, leading to almost similar mean CBA's rate (3.2%) to that of EU27. Youth Unemployment was found at very high levels in Anatoliki Makedonia, Thraki (GR11, 40.7%) and Yuzhen tsentralen (BG42, 31.8%), in relation to Yugozapaden (BG41, 15.2%), producing a much higher CBA rate (29.2%) than the corresponding EU27 value (21%).
- The Population at Risk of Poverty Index reached almost 20% in the Greece – Bulgaria CBA, with increased rates in Anatoliki Makedonia, Thraki (GR11, 25.4%) and Yuzhen tsentralen (BG42, 22.6%). Infant Mortality in the CBA (6.7%) depicted a relatively moderate deviation compared to the correspondent EU27 (4.3%).
- Social cohesion indicators (total, long-term and youth unemployment) over the period 1999 – 2011 showed a general decreasing trend, until year 2008. After 2008, all indicators increased sharply, returning back to the 1997 levels.

Chapter 7 – Integrated Territorial Analysis

7.1. Aims, Indicators and Methods

Institutional arrangement and governance represent an important factor of territorial performance, including cross-border areas. There may be various relations between relevant actors based on different levels of cooperation and competition which influence all the themes presented in the previous sections. Similarly, a number of tools may be applied in this regard. This way the examined variables are linked to the overall characteristics of the different regions, on the themes considered (as demography, accessibility, rural-urban relationship and Lisbon/Gothenburg/Europe 2020 indicators), intending to explore the relations between regions' territorial profile and the regions performance. The hypothesis here is that the performance of cross-border areas is conditioned by institutional structures and governance and that there is a potential of improving the performance via policy actions. This hypothesis will be addressed in the subsequent scenarios-building, based on the relevant ESPON methodologies. The main objectives of this analysis are:

- To relate the performance analysis with the policy structures and actions. In particular, attention will be paid to the question whether and how the stakeholder can influence the territorial performance; and
- To produce baseline scenarios without political actions, on one hand, and prospective scenarios, based on political actions on the other.

Data for this analysis were examined at the NUTS3 scale for all EU27 countries. Some of the overseas areas of Portugal, France and Spain where excluded from this analysis, as data were missing for some of the variables. The year of reference for most data was 2008, since in this year most data are available for most countries. This means that the examined dataset and the subsequent analysis and produced results do not reflect the impact of the financial crisis, which is especially meaningful for volatile indicators, such as migration rates or unemployment rates or the per cent of the Gross Value Added by different economic sectors.

In case of missing values, several procedures where adopted:

1) Search for data in different sources - this method was forcibly used to a very limited extend, as it is very time-consuming;
2) Use of a different time reference;

3) Use of different geographical units - this is especially relevant for the performance indicators where data is often only available for NUTS 2, leading to clustered results;

4) Estimation through SPSS EM procedure.

Two sets of indicators were established: one for territorial profile variables and one for territorial performance variables.

The first set considered variables linked to overall territorial characteristics of the different regions, on the themes considered (Table 49). Polycentricity was excluded at this point, as it makes no sense on a NUTS 3 level at which the analysis was performed. On the other hand, indicators that are normally associated with the Lisbon/Europe 2020 and Gothenburg objectives at the input level (such as R&D investment, active population with tertiary education and so forth) have also been included, since the differentiation was made between dependent and independent variables and not merely based on thematic categories. Unlike most studies on innovation, the EPO patent applications have also been included at this level. This is because, although they can be understood as an output of innovation, innovation in itself is an input for economic performance.

The second set considered variables linked to the performance of the regions concerning indicators related to the Lisbon/Europe 2020 and Gothenburg indicators at the output level.

In order to analyse the relations between the territorial profile and the regions performance, two different analysis where performed. First, a factor analysis for each set of indicators. Second, several multiple linear regressions having as independent variables each factor of the performance indicators and as dependent variables all the factors of the territorial profile.

Table 49. Indicators for territorial profile analysis of the EU27 NUTS3 areas.

Indicator	Units	Year	Geographical unit
Population density	inhabitant/km2	2009	NUTS 3
Crude rate of pop increase	per 1000	2008	NUTS 3
Crude rate net migration	per 1000	2008	NUTS 3
Crude rate of natural increase	per 1000	2008	NUTS 3
Young age dependency	%	2008	NUTS 3
Old age dependency	%	2008	NUTS 3
Total fertility rate		2008	NUTS 2
Commuters to other region	per 1000	2009	NUTS 2
Rural typology	nominal	2008	NUTS 3
Agricultural area	%	2006	NUTS 3
Annual growth rate of agricultural areas	per 10000	1990-2006	NUTS 3
Net formation of urban fabric by total area	per 10000	2000-2006	NUTS 3
Potential accessibility by air index	%	2006	NUTS 3
Potential accessibility by rail index	%	2006	NUTS 3
Potential accessibility by road index	%	2006	NUTS 3
Change of the standardized rail index	%	2001-2006	NUTS 3
Change of the standardized road index	%	2001-2006	NUTS 3
Change of the standardized air index	%	2001-2006	NUTS 3
Employment in Agriculture, Forestry and Fishing	%	2008	NUTS 3
Employment in Industry (except construction)	%	2008	NUTS 3
Employment in Construction	%	2008	NUTS 3
Employment in Wholesale and Retail trade	%	2008	NUTS 3
Employment in Financial Intermediation & Real Estate	%	2008	NUTS 3
Employment in Public Administration	%	2008	NUTS 3
GVA by Agriculture, Forestry and Fishing	%	2008	NUTS 3
GVA by Industry (except construction)	%	2008	NUTS 3
GVA by Construction	%	2008	NUTS 3
GVA by Wholesale and Retail Trade	%	2008	NUTS 3
GVA by Financial Intermediation & Real Estate	%	2008	NUTS 3
GVA by Public Administration	%	2008	NUTS 2
Total intramural R&D expenditure by GDP	%	2007	NUTS 2
Intramural R&D of business enterprise sector by GDP	%	2007	NUTS 2
Intramural R&D of government sector by GDP	%	2007	NUTS 2
Intramural R&D of higher education sector by GDP	%	2007	NUTS 2
EPO patents per million of inhabitants by GDP	%	2007	NUTS 2
Employed persons in high and medium tech manufacturing activities by total workforce	%	2004	NUTS 2
Population aged 25-64 with tertiary education	%	2010	NUTS 2
Physical sensitivity to climate change	rate	n/a	NUTS 3
Social sensitivity to climate change	rate	n/a	NUTS 3
Environmental sensitivity to climate change	rate	n/a	NUTS 3
Cultural sensitivity to climate change	rate	n/a	NUTS 3
Economic sensitivity to climate change	rate	n/a	NUTS 3

Table 50. Indicators for territorial performance analysis of the EU27 NUTS3 areas.

Indicator	Units	Year	Geographical unit
Unemployment rate	%	2008	NUTS 3
Long-term unemployment rate (>=12 months)	%	2009	NUTS 2
Youth unemployment rate, per labour force aged 15-24	%	2008	NUTS 3
Infant mortality rate	%	2008	NUTS 2
GDP per capita indexed EU average	%	2008	NUTS 3
Catching-up Index	nominal	1997-2008	NUTS 3
Natura 2000 area	%	2006	NUTS 3
Ozone concentration exceedance, per year	%	2008	NUTS 3
Waste water treatment capacity	%	2007	NUTS 2
Soil sealed area	%	2006	NUTS 3

7.2. Territorial Profile Analysis

Factor analysis was applied on the indicators for terrirorial profile matrix (Table 49), aiming a) to obtain a small set of variables (preferably uncorrelated) from a large set of variables (most of which are correlated to each other), and b) to create indexes (called factors) with variables that measure similar things. Present factor analysis results are shown in Table 51. It occurs that eleven factors having eigenvalues higher than 1 (based on the Kaiser criterion), are derived from this analysis, explaining cumulatively 74.327% of the total system's variance. By default, axes rotation is Varimax, implying that the factors produced are orthogonal, and therefore, not correlated to each other. Table 52 presents the indicators defining each of the eleven system's factors together with the corresponding rotated factor loadings.

Table 51. Factor analysis results on the indicators for terrirorial profile matrix for the NUTS3 areas of the EU27 space.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.892	21.171	21.171	8.892	21.171	21.171	6.228	14.828	14.828
2	5.637	13.422	34.593	5.637	13.422	34.593	3.528	8.401	23.229
3	3.225	7.679	42.271	3.225	7.679	42.271	3.51	8.357	31.586
4	2.544	6.057	48.328	2.544	6.057	48.328	3.033	7.221	38.807
5	2.391	5.692	54.02	2.391	5.692	54.02	2.904	6.915	45.722
6	1.933	4.602	58.622	1.933	4.602	58.622	2.487	5.921	51.643
7	1.697	4.039	62.662	1.697	4.039	62.662	2.373	5.649	57.292
8	1.373	3.27	65.932	1.373	3.27	65.932	2.189	5.213	62.505
9	1.282	3.051	68.983	1.282	3.051	68.983	2.017	4.802	67.306
10	1.158	2.758	71.741	1.158	2.758	71.741	1.565	3.727	71.033
11	1.086	2.586	74.327	1.086	2.586	74.327	1.383	3.294	74.327

Table 52. Rotated factor loadings of terrirorial profile factor analysis.

	Rotated Component Matrix										
	1	2	3	4	5	6	7	8	9	10	11
empl_agric_fish	-0,841										
Rail_index	0,806										
GVA_agric_fish	-0,801										
Road_index	0,783										
air_index	0,752										
employ_finan_r_estate	0,649										
Commuter_region	0,594										
High_tech_employ	0,57										
GVA_finan_r_estate	0,551										
Rural_typology	-0,511										
air_index_ch											
GERD		0,898									
BERD		0,798									
GOVERD		0,687									
HERD		0,633									
Tertiary_ed_act_pop		0,533									
EPO_patents		0,509									
GVA_adm_comm_serv			0,878								
employ_adm_comm_serv			0,825								
employ_industry			-0,785								
GVA_industry			-0,736								
Young_dep				0,814							
TFR				0,747							
Nat_increase				0,687							
Old_dep				-0,653							
Rail_index_ch				-0,521							
sens_phys					0,852						
sens_soc					0,843						
sens_cult					0,774						
sens_env											
GVA_trade_transp						0,837					
employ_trade_transp						0,836					
Net_migration							0,897				
Pop_increase							0,861				
sens_econ											
employ_construction								0,851			
GVA_construction								0,791			
Formation_urban_fabric											
Pop_density									-0,751		
Growth_agric_area									0,673		
Road_index_ch										-0,672	
Percent_agric_area											0,669

Reults show that Factor 1 expresses the 'proximity to central urban centers' (or else centrality) of the NUTS3 areas of the EU27 space. This factor explains 14.83% of the total system's variance. Factor 1 has high positive correlations with all the indicators expressing potential accessibility and, to a lesser extent, with the share of employment in the financial intermediation and real estate, the employment in high and medium tech manufacturing activities and with commuting to other regions. It also has a strong negative correlation with the share of employment and GVA in agriculture and fishing.

Mapping the spatial distribution of factor scores for Factor 1 (Figure 62), it is seen that this factor has its highest values in central European countries, especially in the Ruhr, Belgium and Southern England areas, in a pattern that clearly lines out the blue banana. In the less central regions, the higher values tend to be concentrated around capitals and other major urban agglomerations.

The Greece – Bulgaria CBA shows very low factor scores ranging between -3.73 (Kardzhali, BG425) and -0.01 (Sofia stolitsa, BG411). Most NUTS3 areas score at the lowest 5th and 20th percentilles of all EU27 areas. Weighting these factor scores to the national factor score (BG = -1.53; GR = -1.17), a cluster with positive factor scores (i.e., with relatively increased centrality at national level) is formed comprised of Sofia stolitsa (BG411, 1.51), Pernik (BG414, 0.83) and Plovdiv (BG421, 0.13) (Table 53). In Anatoliki Makedonia, Thraki (GR11), all NUTS3 level regions depict negative values (i.e., limited centrality at national level). Weighting these factor scores to the average of all examined Cross-border Regions (CBR), only Sofia stolitsa (BG411, 1.16), Pernik (BG414, 0.47) and Kavala (GR115, 0.03) depict relatively increased 'centrality' (Table 53).

Table 53. Factor scores for Factor 1 (centrality) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 1						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	-1.17						20
BG	Bulgaria	-1.53				-0.35		20
GR	Greece	-0.93				0.24		20
BG411	Sofia (stolitsa)	-0.01	1.51			1.16	+ +	50
BG412	Sofia	-1.74	-0.22			-0.57	- -	20
BG413	Blagoevgrad	-2.18	-0.65			-1.01	- -	5
BG414	Pernik	-0.70	0.83			0.47	+ +	50
BG415	Kyustendil	-1.63	-0.11			-0.46	- -	20
BG421	Plovdiv	-1.39	0.13			-0.22	- +	20
BG422	Haskovo	-2.19	-0.66			-1.02	- -	5
BG423	Pazardzhik	-2.18	-0.66			-1.01	- -	5
BG424	Smolyan	-2.10	-0.58			-0.93	- -	5
BG425	Kardzhali	-3.73	-2.21			-2.56	- -	5
GR111	Evros	-1.57		-0.64		-0.40	- -	20
GR112	Xanthi	-1.88		-0.95		-0.71	- -	20
GR113	Rodopi	-2.63		-1.70		-1.46	- -	5
GR114	Drama	-1.55		-0.62		-0.38	- -	20
GR115	Kavala	-1.14		-0.21		0.03	+ -	20

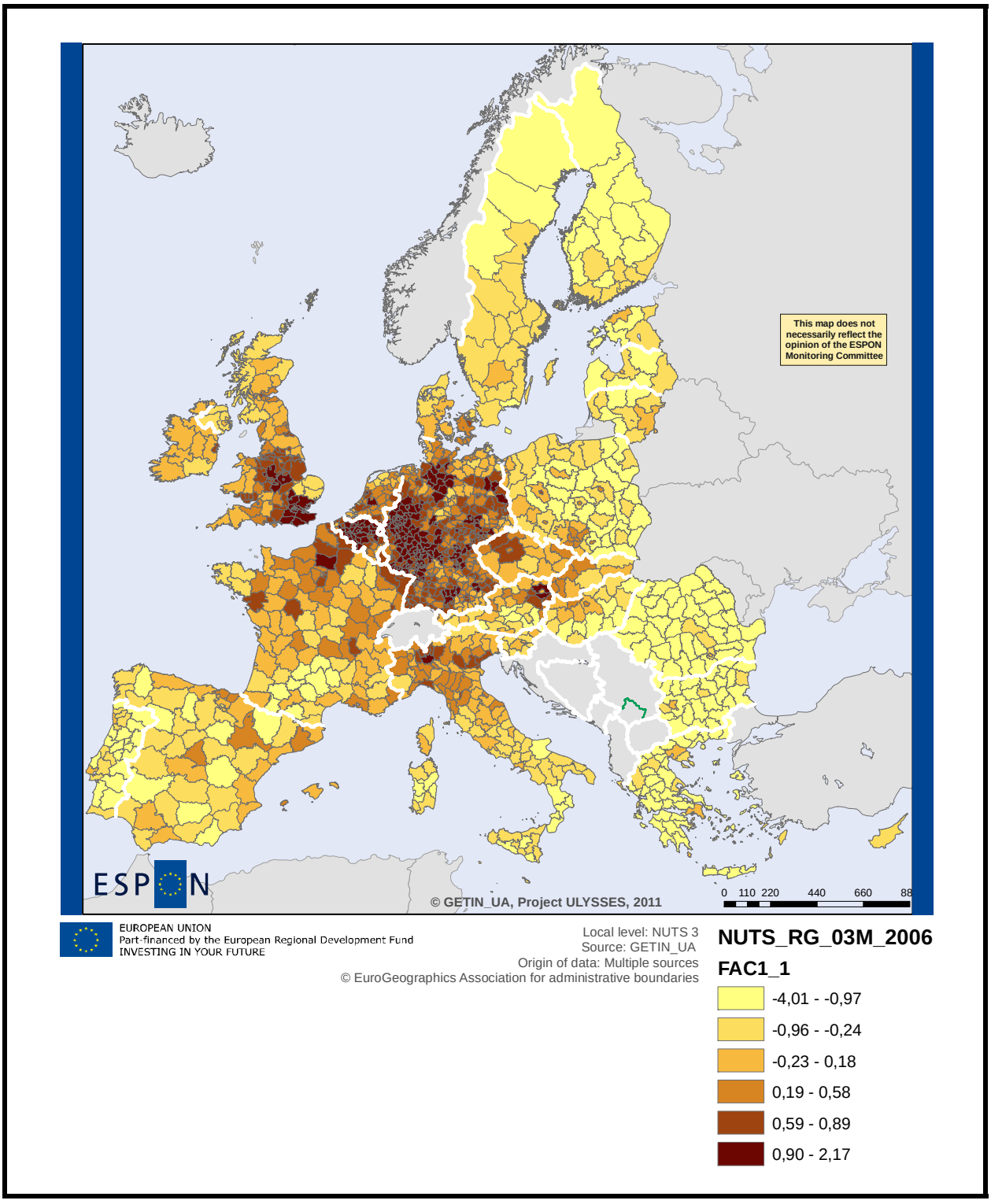

Figure 62. Spatial distribution of rotated factor scores for factor 1 representing the 'proximity to central urban centers'.

Results show that Factor 2 represents the innovation dynamic and the scientific development of each NUTS3 area of the EU27 space. Factor 2 appears mostly related to R&D investment of the different sectors and, to a lesser extent, to EPO patent application and the tertiary educated active population. This factor explains 8.40% of the total system's variance. Mapping the spatial distribution of factor scores for Factor 2 (Figure 63), it is interesting to note that, besides the capital cities, it is possible to identify specific innovation strongholds such as important university towns or high tech industries (Airbus in the Toulouse area, Volkswagen around Wolfsburg, Cambridge or the Silicon Glen). The Scandinavian countries also have a very favourable position in this factor.

The Greece – Bulgaria CBA shows relatively low factor scores ranging between -0.94 (Plovdiv, BG421) and +0.50 (Blagoevgrad, BG413). Most areas score at the 50th percentile of all EU27 NUTS3 areas. Weighting these factor scores to the national factor score (BG = -0.54; GR = -0.45), a cluster with negative factor scores (i.e., with relatively reduced R&D investments at national level) is formed comprised of Plovdiv (BG421, -0.41), Pazardzhik (BG423, -0.28) and Haskovo (BG422, -0.15). (Table 54). In Anatoliki Makedonia, Thraki (GR11), all NUTS3 level regions depict negative values (i.e., limited R&D investments relative to the national average), apart of Rodopi (GR113, +0.12). Weighting these factor scores to the average of all examined Cross-border Regions (CBR), all Yugozapaden NUTS3 areas, together with Smolyan (BG424, +0.01) and Kardzhali (BG425, +0.23), form a group of relatively increased R&D spending (Table 54).

Table 54. Factor scores for Factor 2 (R&D investments) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 2						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	-0.48						50
BG	Bulgaria	-0.54				-0.05		50
GR	Greece	-0.45				0.04		50
BG411	Sofia (stolitsa)	-0.03	0.50			0.45	+ +	80
BG412	Sofia	0.17	0.71			0.66	+ +	80
BG413	Blagoevgrad	0.50	1.03			0.98	+ +	80
BG414	Pernik	-0.25	0.28			0.23	+ +	50
BG415	Kyustendil	0.30	0.84			0.78	+ +	80
BG421	Plovdiv	-0.94	-0.41			-0.46	- -	20
BG422	Haskovo	-0.69	-0.15			-0.20	- -	50
BG423	Pazardzhik	-0.82	-0.28			-0.34	- -	20
BG424	Smolyan	-0.47	0.07			0.01	+ +	50
BG425	Kardzhali	-0.26	0.28			0.23	+ +	50
GR111	Evros	-0.62		-0.17		-0.14	- -	50
GR112	Xanthi	-0.52		-0.07		-0.04	- -	50
GR113	Rodopi	-0.33		0.12		0.15	+ +	50
GR114	Drama	-0.74		-0.29		-0.25	- -	50
GR115	Kavala	-0.65		-0.21		-0.17	- -	50

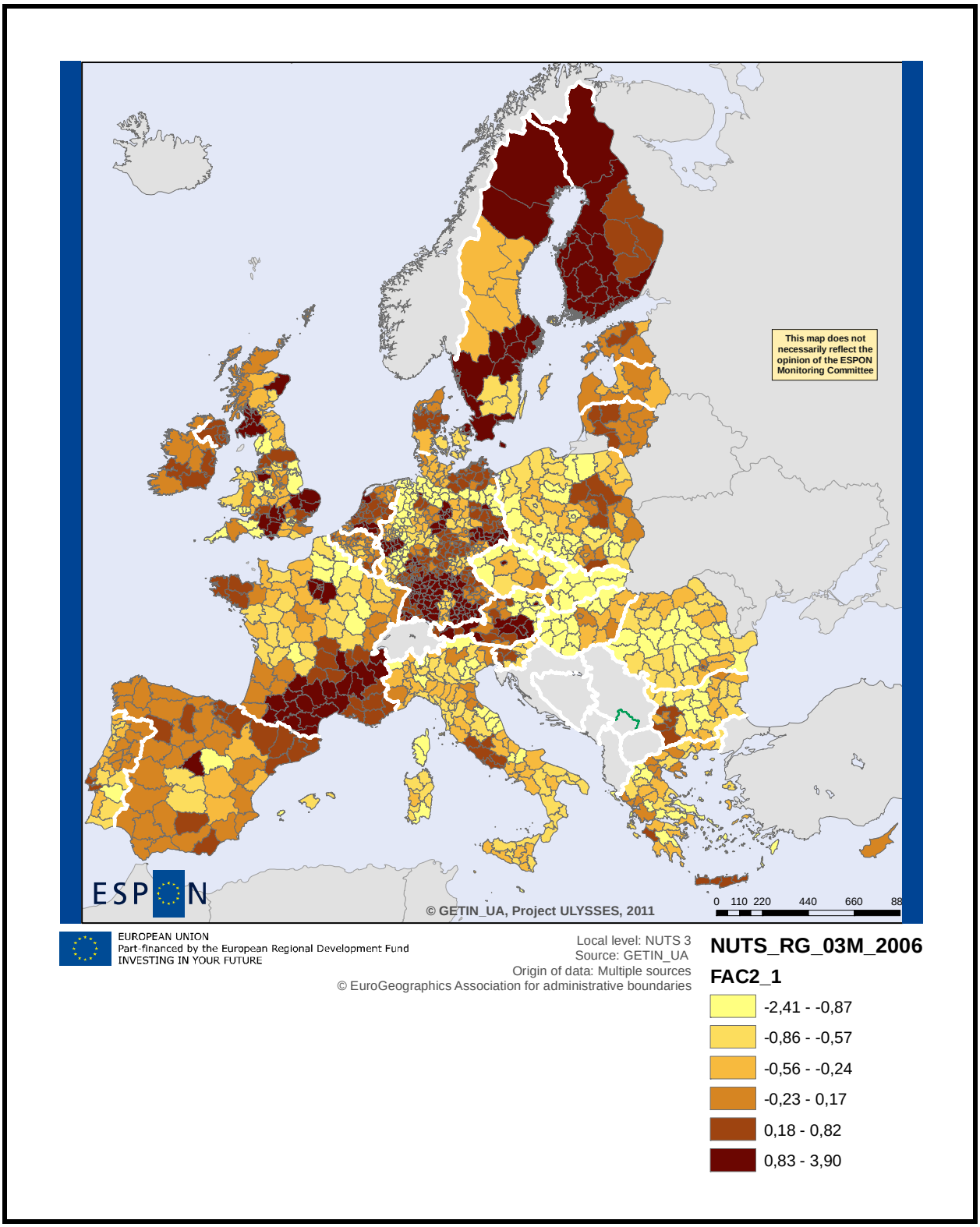

Figure 63. Spatial distribution of rotated factor scores for factor 2 representing the 'R&D investments'.

Regarding Factor 3, it appears to represent the proximity of NUTS3 areas to public administration centres, as the indicators positively correlated with this factor are the share of employment and the GVA in public administration, community services and activities of household and the indicators negatively correlated with this factors are the share of employment and the GVA in industry. This factor explains 8.36% of the total system's variance. The regions with the highest scores of this factor are majorly depressed regions in which, because of their poor economic performance, the public sector assumes an important position (Figure 64). It is interesting to see that most of the borders NUTS3 areas in Spain and Portugal have very high scores in this factor, as well as Karelia. The other cross-border regions seem to be closer to the national patterns. On a different note, this indicator also relates to the different levels of state interventionism, with the Scandinavian countries and France revealing overall high scores.

The Bulgarian NUTS3 areas of the Greece – Bulgaria CBA shows relatively low factor scores ranging between -1.72 (Pernik, BG414) and -0.21 (Kardzhali, BG425). On the contrary, all NUTS3 areas of Anatoliki Makedonia, Thraki region show high positive factor scores (mean = +0.73). These areas score up to the 80th and even 95th percentile of all EU27 NUTS3 areas. Weighting these factor scores to the national factor score (BG = -0.80; GR = +0.22), a cluster with positive factor scores (i.e., with relatively increased administrative significance at national level) is formed comprised of most Anatoliki Makedonia, Thraki NUTS3 areas (except of Xanth GR113), Kardzhali (BG425), Smolyan (BG424), Haskovo (BG422), Kyustendil (BG415) and Sofia stolitsa (BG411). Weighting these factor scores to the average of all examined Cross-border Regions (CBR), only the Greek NUTS3 areas form a group of strongly increased administrative employment and GVA (Table 55).

Table 55. Factor scores for Factor 3 (public administration) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 3						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	-0.19						50
BG	Bulgaria	-0.80				-0.61		50
GR	Greece	0.22				0.41		80
BG411	Sofia (stolitsa)	-0.76	0.05			-0.57	- +	50
BG412	Sofia	-1.49	-0.69			-1.30	- -	20
BG413	Blagoevgrad	-1.11	-0.31			-0.92	- -	20
BG414	Pernik	-1.72	-0.92			-1.53	- -	20
BG415	Kyustendil	-0.72	0.08			-0.53	- +	50
BG421	Plovdiv	-1.05	-0.25			-0.86	- -	20
BG422	Haskovo	-0.60	0.20			-0.41	- +	50
BG423	Pazardzhik	-1.18	-0.37			-0.98	- -	20
BG424	Smolyan	-0.67	0.13			-0.48	- +	50
BG425	Kardzhali	-0.21	0.59			-0.02	- +	50
GR111	Evros	1.39		1.16		1.58	+ +	95
GR112	Xanthi	0.13		-0.09		0.32	+ -	80
GR113	Rodopi	0.22		0.00		0.41	+ -	80
GR114	Drama	1.22		1.00		1.41	+ +	95
GR115	Kavala	0.71		0.49		0.90	+ +	80

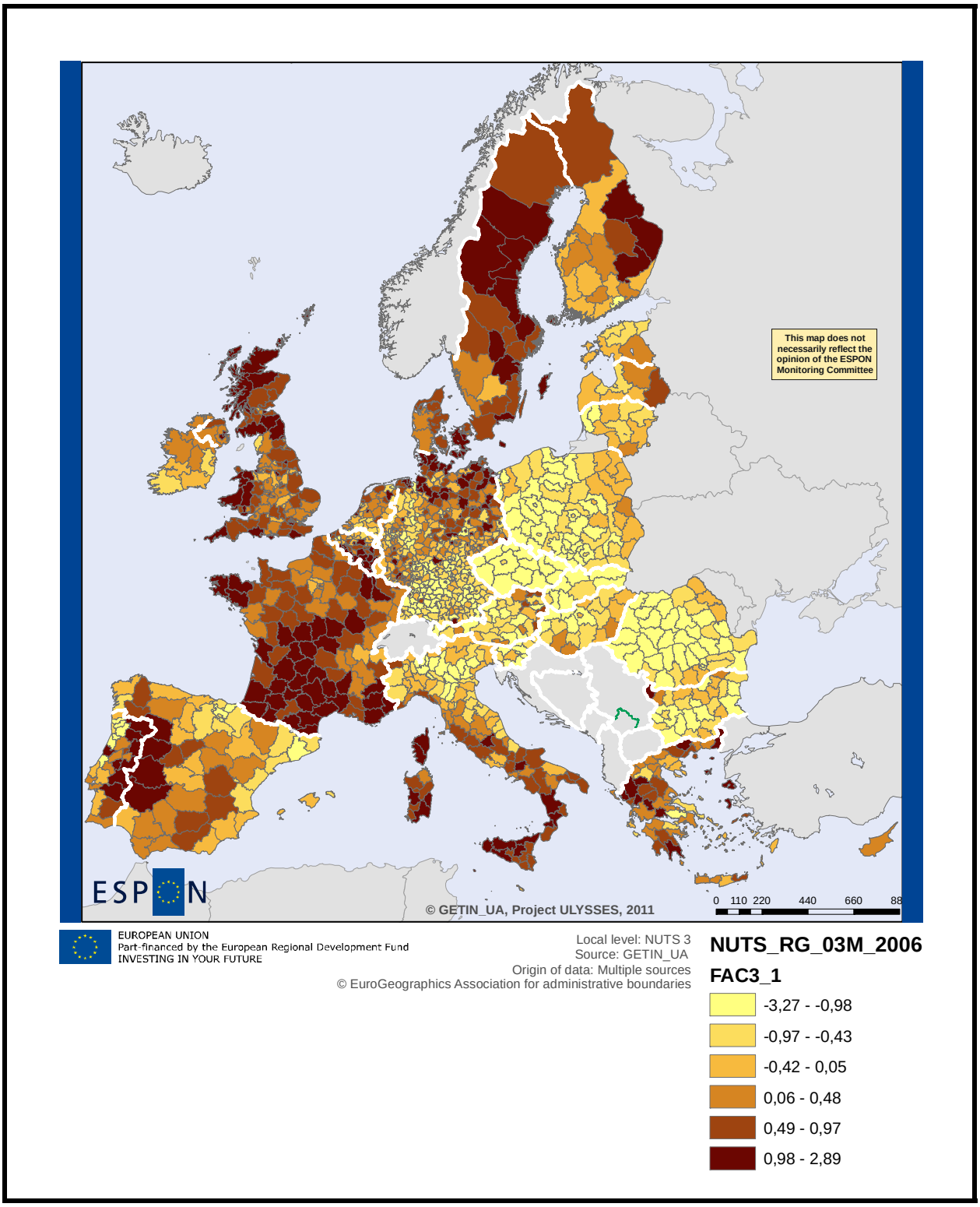

Figure 64. Spatial distribution of rotated factor scores for factor 3 representing the 'public administration centers'.

Factor 4 seems expressing the deographic dynamism of NUTS3 areas, as the indicators positively correlated with this factor are the young age dependency rate, the crude rate of natural population increase and the total fertility rate. This factor depicts negative correlation to the old age dependency rate parameter. This factor explains 7.22% of the total system's variance.

Mapping the spatial distribution of factor scores it occurs that the region with the lowest scores of this factor are in the Mediterranean countries, such as Portugal, Spain and Greece, as well as Germany. On the contrary, the northern parts of France, Ireland, central Great Britain, Scondinavia and eastern Europe are the regions with the highest positive scores (Figure 65).

In the Bulgarian NUTS3 areas of the Greece – Bulgaria CBA all NUTS3 areas (with the exception of Xanthi, GR113, +1.07) show negative factor scores, ranging between -0.99 (Kyustnedil, BG415) and 0.00 (Blagoevgrad, BG413 and Kardzhali, BG425). These areas score at the level of the 5th percentile of all EU27 NUTS3 areas. Weighting these factor scores to the national factor score (BG = -0.23; GR = -0.25), a cluster with positive factor scores (i.e., with relatively increased demographic dynamism at national level) is formed comprised of Blagoevgrad (BG413), Pazardzhik (BG423), Kardzhali (BG425), Rodopi (GR114) and Xanthi (GR113) (Table 56).

Table 56. Factor scores for Factor 4 (demographic dynamism) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 4						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	-0.24						5
BG	Bulgaria	-0.23				0.01		5
GR	Greece	-0.25				-0.01		5
BG411	Sofia (stolitsa)	-0.32	-0.09			-0.08	- -	5
BG412	Sofia	-0.42	-0.19			-0.18	- -	5
BG413	Blagoevgrad	0.00	0.23			0.24	+ +	5
BG414	Pernik	-0.44	-0.21			-0.20	- -	5
BG415	Kyustendil	-0.99	-0.76			-0.75	- -	5
BG421	Plovdiv	-0.30	-0.07			-0.06	- -	5
BG422	Haskovo	-0.47	-0.24			-0.23	- -	5
BG423	Pazardzhik	0.13	0.36			0.37	+ +	5
BG424	Smolyan	-0.58	-0.35			-0.34	- -	5
BG425	Kardzhali	0.00	0.23			0.24	+ +	5
GR111	Evros	-0.33		1.16		-0.09	- -	5
GR112	Xanthi	1.07		-0.09		1.31	+ +	5
GR113	Rodopi	-0.06		0.00		0.18	+ +	5
GR114	Drama	-0.36		1.00		-0.12	- -	5
GR115	Kavala	-0.37		0.49		-0.13	- -	5

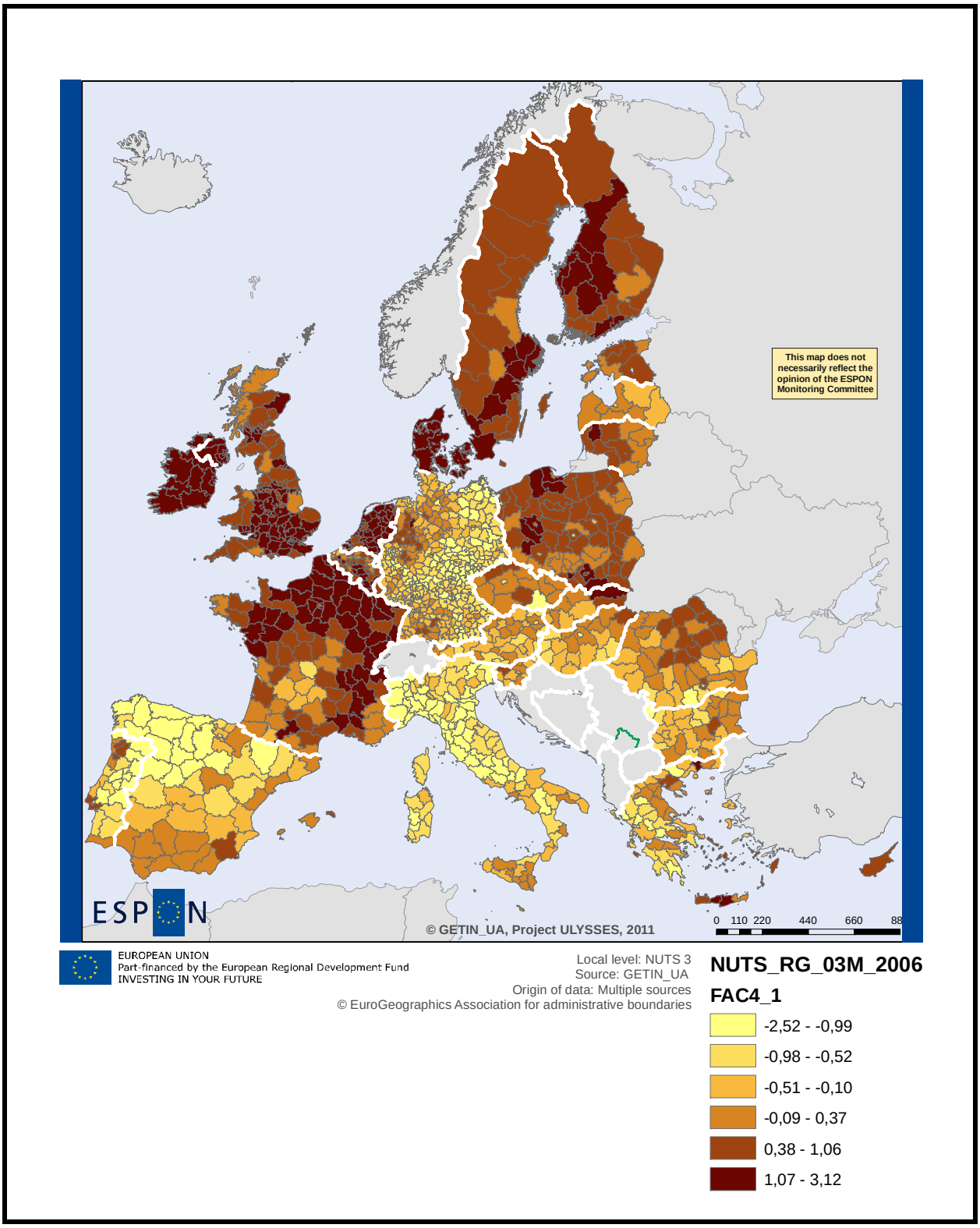

Figure 65. Spatial distribution of rotated factor scores for factor 4 representing 'demographic dynamism'.

Factor 5 appears related to NUTS3 areas' sensitivity to climate change, as this factor is correlated with the environmental, social and cultural sensitivity indicators. This factor explains 6.91% of the total system's variance. Mapping the spatial distribution of factor scores it occurs that the highly sensitive to climatic change risks are regions essentially located in coastal areas and other flood prone areas, such as areas close to the Delta of Danube River or Po River (Figure 66).

Focusing on the Greece – Bulgaria CBA, it can be seen that most Bulgarian NUTS3 areas show positive factor scores, indicating their relative exposure to climate change. Exceptions are areas with negative factor scores as Pernik (BG414, -0.30), Kardzhali (BG425, -0.04), Pazardzhik (BG423, -0.04) and Sofia stolitsa (BG411, -0.01). All NUTS3 areas of Anatoliki Makedonia, Thraki show relatively lower climate change risk, when compared to all NUTS3 areas of the EU27 space. Thus, most NUTS3 areas score at the level of 50th and 80th percentile of all EU27 NUTS3 areas.

Weighting these factor scores to the national factor score (BG = +0.07; GR = +0.25), two clusters are formed in Bulgaria, with areas having a higher climate change sensitive degree than national average and those below national average (Table 57). In Anatoliki Makedonia, Thraki, all NUTS3 areas appear below the national average in terms of climate change sensitivity.

Table 57. Factor scores for Factor 5 (climate change sensitivity) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 5						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	0.18						80
BG	Bulgaria	0.07				-0.10		80
GR	Greece	0.25				0.07		80
BG411	Sofia (stolitsa)	-0.01	-0.08			-0.19	- -	80
BG412	Sofia	0.08	0.01			-0.10	- +	80
BG413	Blagoevgrad	0.34	0.26			0.16	+ +	80
BG414	Pernik	-0.30	-0.37			-0.48	- -	50
BG415	Kyustendil	0.19	0.12			0.01	+ +	80
BG421	Plovdiv	0.49	0.42			0.31	+ +	95
BG422	Haskovo	0.19	0.11			0.01	+ +	80
BG423	Pazardzhik	-0.04	-0.12			-0.22	- -	80
BG424	Smolyan	0.02	-0.05			-0.16	- -	80
BG425	Kardzhali	-0.04	-0.12			-0.22	- -	80
GR111	Evros	-0.42		-0.67		-0.60	- -	50
GR112	Xanthi	-0.68		-0.93		-0.86	- -	50
GR113	Rodopi	-0.53		-0.78		-0.71	- -	50
GR114	Drama	-0.91		-1.15		-1.08	- -	20
GR115	Kavala	-0.63		-0.88		-0.80	- -	50

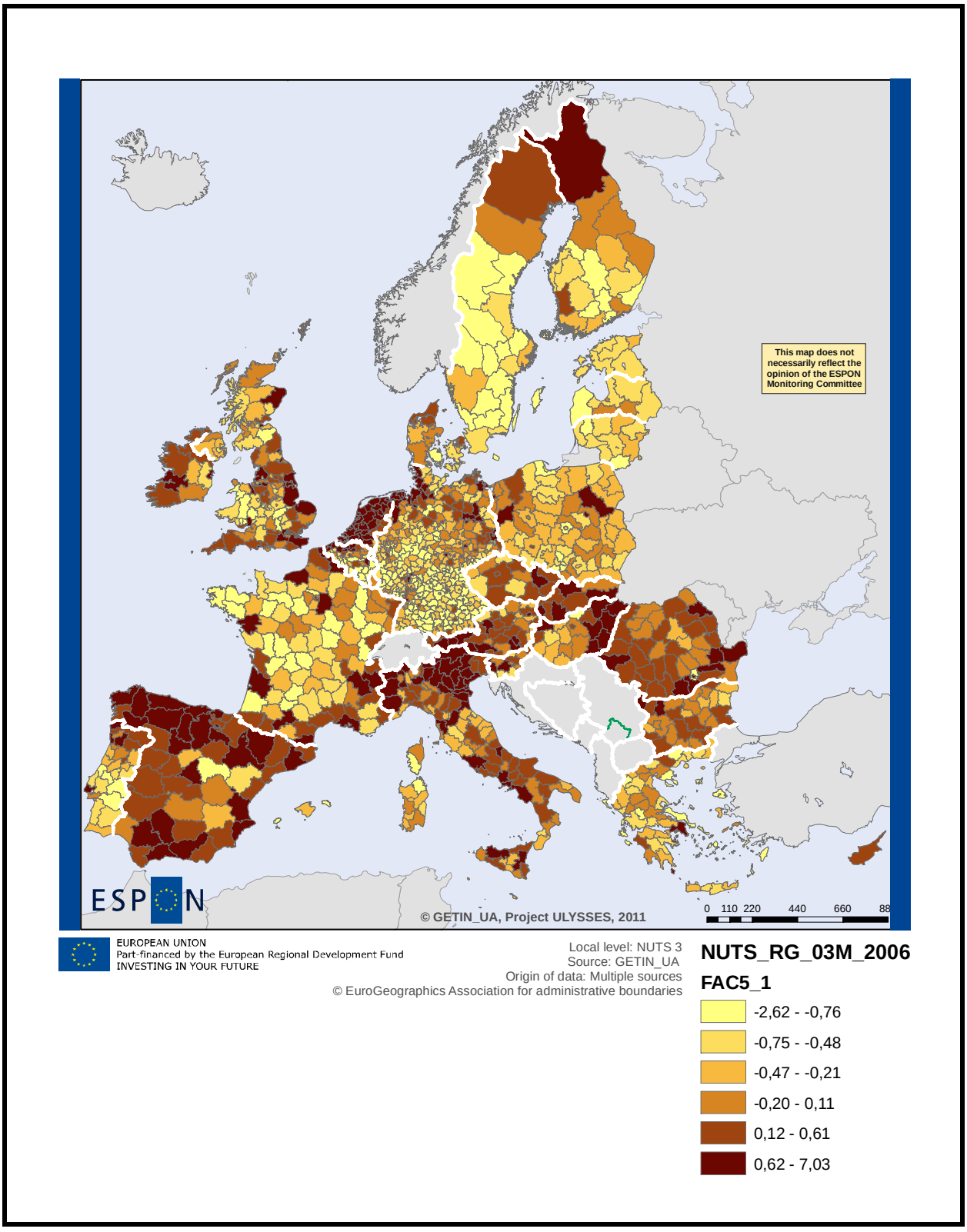

Figure 66. Spatial distribution of rotated factor scores for factor 5 representing 'climate change sensitivity'.

Factor 6 appears related to trade, tourist services and transport, since positively correlated to this factor are indicators as the share of employement and the GVA produced by the wholesale and retail trade, hotels and restaurants and transport sector (NACE G-I). This factor explains 5.92% of the total system's variance.

Mapping the spatial distribution of factor scores in Factor 6 (Figure 67) it may be noted that many of the regions with the high scores seem to be linked to tourism (as Southern Spain and Portugal, the alpine regions, Paris, Greece, Rome, etc.).

Focusing in the Greece – Bulgaria CBA, it can be seen that almost all NUTS3 areas show positive factor score, indicating the high impact of trade, tourism and transport in local economy. Exceptions are most Yugozapaden areas (only Sofia stolitsa (BG411) has positive factor score), Pazardzhik (BG423, -0.74), Smolyan (BG424, -0.48) and Kardzhali (BG425, -1.13). Most NUTS3 areas lie with the 50th and 80th percentiles of the EU27 factor scores distribution. When comparing to the national average (BG = +0.41; GR = +1.92), all CBA areas score below their national average level, apart of Sofia stolitsa (BG411, +2.28). Similarly, when compared the CBR average value (+1.31), all CBA areas score below that level, with the exception of Sofia stolitsa (BG411, +1.38) (Table 58).

Table 58. Factor scores for Factor 6 (trade, tourism and transport) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 6						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	1.31						95
BG	Bulgaria	0.41				-0.90		80
GR	Greece	1.92				0.61		> 95
BG411	Sofia (stolitsa)	2.68	2.28			1.38	+ +	> 95
BG412	Sofia	-0.36	-0.76			-1.66	- -	50
BG413	Blagoevgrad	-0.68	-1.08			-1.98	- -	50
BG414	Pernik	-1.08	-1.49			-2.39	- -	20
BG415	Kyustendil	-0.78	-1.18			-2.08	- -	20
BG421	Plovdiv	0.38	-0.03			-0.93	- -	80
BG422	Haskovo	0.26	-0.15			-1.05	- -	80
BG423	Pazardzhik	-0.74	-1.15			-2.05	- -	50
BG424	Smolyan	-0.48	-0.89			-1.79	- -	50
BG425	Kardzhali	-1.13	-1.54			-2.44	- -	20
GR111	Evros	0.20		-1.72		-1.11	- -	80
GR112	Xanthi	0.14		-1.77		-1.16	- -	80
GR113	Rodopi	0.89		-1.03		-0.42	- -	95
GR114	Drama	0.37		-1.54		-0.93	- -	80
GR115	Kavala	1.30		-0.62		-0.01	- -	95

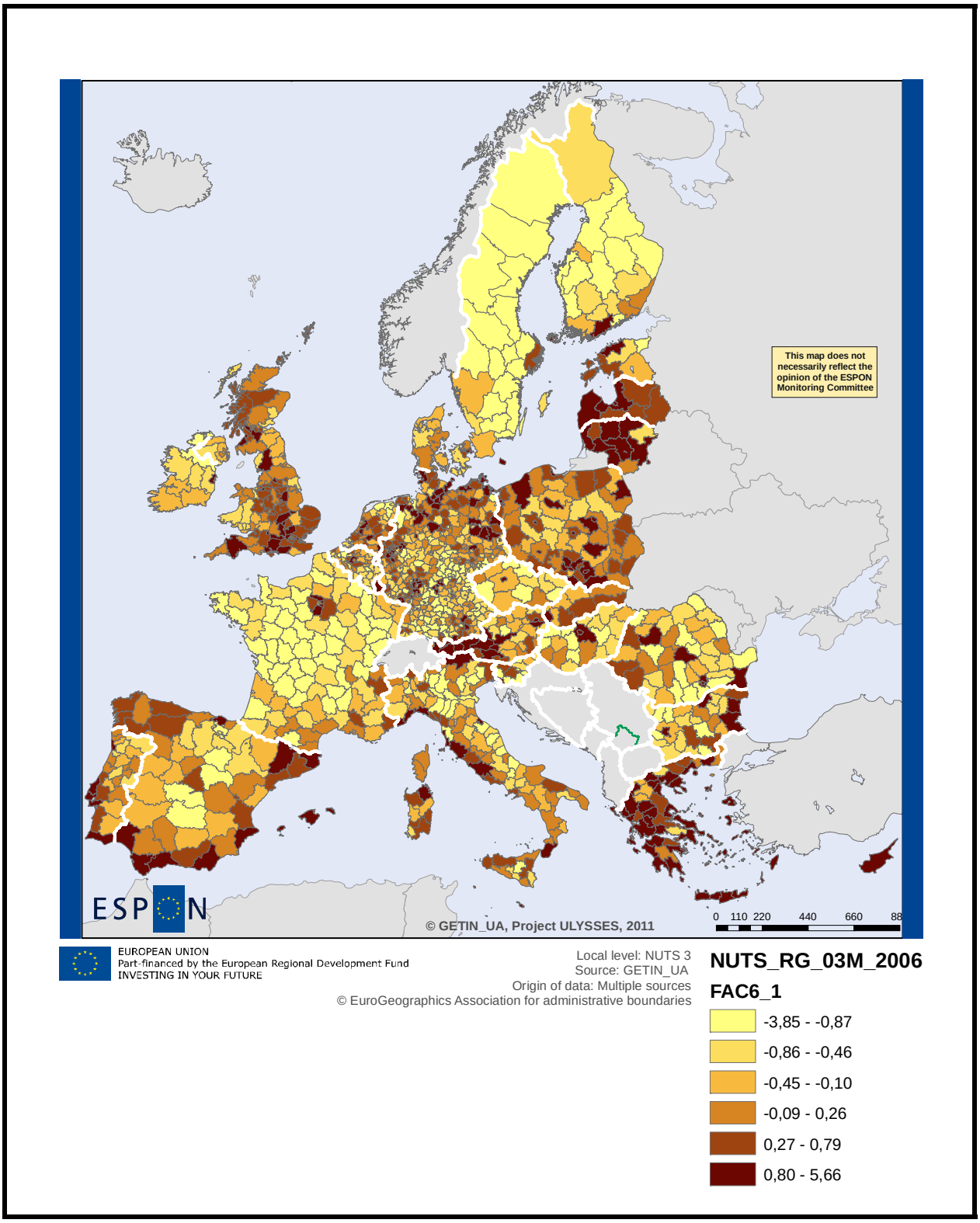

Figure 67. Spatial distribution of rotated factor scores for factor 6 representing 'trade, tourism and transport'.

Factor 7 seems related to immigration, since the positively correlated to this factor indicators are population growth and net migration rates. This factor explains 5.64% of the total system's variance.

Mapping the spatial distribution of factor scores in Factor 7 (Figure 68) it occurs that many regions in Central and Western Europe show very high scores in this factor, while in the Eastern Europe countries, these high scores are generally restricted to the capital cities. Interestingly, in Portugal and Finland the border regions in general (and Karelia and the Alentejo in particular) have much lower values than the coastal regions, suggesting an internal migrations process towards the coast.

Focusing in the Greece – Bulgaria CBA, it can be seen that almost all NUTS3 areas depict negative factor score values, implying that these regions show generally negative population growth trends and are not affected by immigration. Evros (GR111, +0.06) and Xanthi (GR112, +0.19) are the only areas with positive factors scores. Most NUTS3 areas lie with the 20th and 50th percentiles of the EU27 factor scores distribution. When comparing to the national average (BG = -0.65; GR = +0.36), all CBA areas score below their national average level, except of Sofia stolitsa (BG411, +0.85). Similarly, when compared the CBR average value (-0.05), all CBA areas score below that level, and only Evros (GR111, +0.11), Xanthi (GR112, +0.24), Rodopi (GR113, +0.04) and Drama (GR114, +0.01) show positive factors scores (Table 59).

Table 59. Factor scores for Factor 7 (immigration) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 7						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	-0.05						80
BG	Bulgaria	-0.65				-0.60		50
GR	Greece	0.36				0.41		80
BG411	Sofia (stolitsa)	0.20	0.85			0.25	+ +	80
BG412	Sofia	-1.32	-0.68			-1.27	- -	20
BG413	Blagoevgrad	-0.86	-0.21			-0.81	- -	20
BG414	Pernik	-1.30	-0.65			-1.25	- -	20
BG415	Kyustendil	-0.79	-0.14			-0.74	- -	20
BG421	Plovdiv	-0.24	0.41			-0.19	- +	50
BG422	Haskovo	-1.20	-0.56			-1.15	- -	20
BG423	Pazardzhik	-0.90	-0.26			-0.85	- -	20
BG424	Smolyan	-1.78	-1.13			-1.73	- -	5
BG425	Kardzhali	-0.71	-0.06			-0.66	- -	50
GR111	Evros	0.06		-0.30		0.11	+ -	80
GR112	Xanthi	0.19		-0.17		0.24	+ -	80
GR113	Rodopi	-0.01		-0.37		0.04	+ -	80
GR114	Drama	-0.04		-0.40		0.01	+ -	80
GR115	Kavala	-0.11		-0.47		-0.06	- -	50

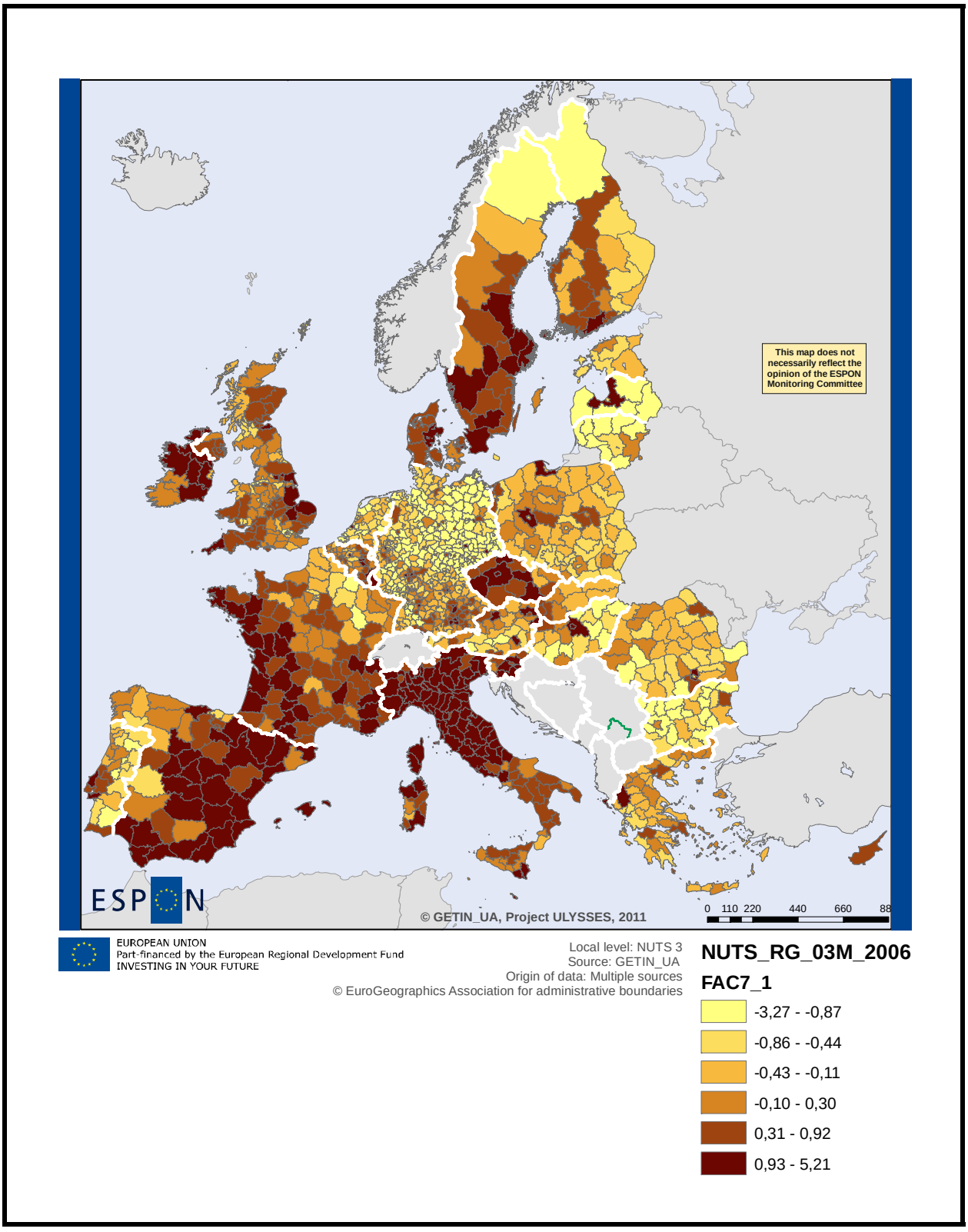

Figure 68. Spatial distribution of rotated factor scores for factor 7 representing 'immigration'.

Factor 8 seems related to the Construction sector, since the positively correlated to this factor indicators are the share of employment and the GVA produced by Construction. This factor explains 5.21% of the total system's variance.

Mapping the spatial distribution of factor scores in Factor 8 (Figure 69) it occurs that the regions with the highest factor scores in this factor appear in Ireland, Spain, the Baltic States and Eastern Germany.

Focusing in the Greece – Bulgaria CBA, it can be seen that almost all NUTS3 areas depict negative factor score values, implying that these regions show generally lower construction sector activities. Blagoevgrad (BG413, +1.05), Sofia stolitsa (BG411, +0.30) and Pernik (BG414, +0.05) are the only areas with positive factors scores, depicting that in these areas the construction sector reveals a strong dynamism. Most NUTS3 areas lie within the 50th percentiles of the EU27 factor scores distribution. When comparing to the national average (BG = -0.26; GR = -0.49), it is shown that the above three NUTS3 areas together with Plovdiv (BG421) and Smolyan (BG424) score above the Bulgarian mean level. In Anatoliki Makedonia, Thraki (GR11), only Evros (GR111) and Kavala (GR155) score above the national average level (Table 60).

Table 60. Factor scores for Factor 8 (construction) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 8						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	-0.40						50
BG	Bulgaria	-0.26				0.14		50
GR	Greece	-0.49				-0.09		50
BG411	Sofia (stolitsa)	0.30	0.56			0.70	+ +	80
BG412	Sofia	-0.61	-0.35			-0.21	- -	50
BG413	Blagoevgrad	1.05	1.30			1.44	+ +	95
BG414	Pernik	0.05	0.31			0.45	+ +	80
BG415	Kyustendil	-0.45	-0.19			-0.05	- -	50
BG421	Plovdiv	-0.24	0.02			0.15	+ +	50
BG422	Haskovo	-0.74	-0.48			-0.34	- -	50
BG423	Pazardzhik	-1.42	-1.16			-1.02	- -	20
BG424	Smolyan	1.84	2.10			2.23	+ +	95
BG425	Kardzhali	-1.54	-1.28			-1.15	- -	5
GR111	Evros	-0.18		0.31		0.22	+ +	50
GR112	Xanthi	-0.76		-0.27		-0.36	- -	20
GR113	Rodopi	-1.56		-1.08		-1.17	- -	5
GR114	Drama	-0.66		-0.17		-0.26	- -	50
GR115	Kavala	-0.04		0.45		0.35	+ +	80

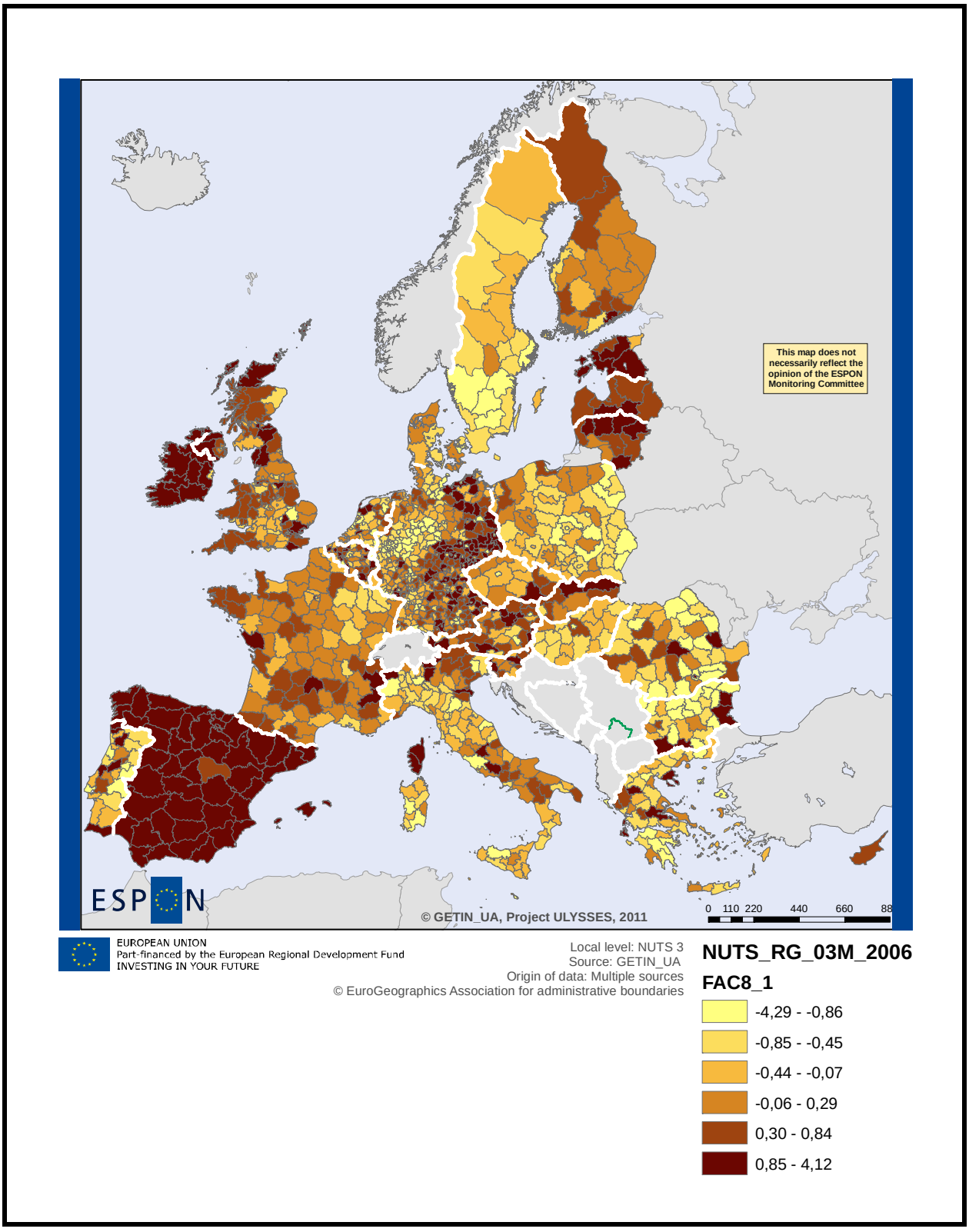

Figure 69. Spatial distribution of rotated factor scores for factor 8 representing 'construction'.

7.3. Territorial Performance Analysis

Factor analysis was applied on the indicators for terrirorial performance matrix (Table 50), aiming a) to obtain a small set of variables (preferably uncorrelated) from a large set of variables (most of which are correlated to each other), and b) to create indexes (called factors) with variables that measure similar things. Present factor analysis results are shown in Table 61. It occurs that only four factors have eigenvalues higher than 1 (based on the Kaiser criterion). These factors explain cumulatively 72.28% of the total system's variance. By default, axes rotation is Varimax, implying that the factors produced are orthogonal, and therefore, not correlated to each other.

Table 62 presents the indicators defining each of the four system's factors together with the corresponding rotated factor loadings. It can be derived that factor 1 represents unemployment, factor 2 the catching-up trend of the regions, factor 3 areas economic development while factor 4 air pollution.

Table 61. Factor analysis results on the indicators for terrirorial performance matrix for the NUTS3 areas of the EU27 space.

Total Variance Explained

	Initial Eigenvalues			Extract Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Comp.	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,898	28,983	28,983	2,898	28,983	28,983	2,419	24,194	24,194
2	1,847	18,471	47,454	1,847	18,471	47,454	1, 871	18,708	42,902
3	1,434	14,344	61,798	1,434	14,344	61,798	1,757	17,568	60,470
4	1,049	10,486	72,284	1,049	10,486	72,284	1,181	11,814	72,284
5	,902	9,017	81,301						
6	,604	6,044	87,345						
7	,439	4,392	91,737						
8	,370	3,697	95,434						
9	,303	3,034	98,468						
10	,153	1,532	100,000						

Extraction Method: Principal Component Analysis.

Table 62. Rotated factor loadings of terrirorial performance factor analysis.

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Unemployment	,947			
Long_unemploy	,884			
Youth_unemploy	,785			
Infant_m		,839		
GDP_pc_index			,755	
Catching_up		,733		
NATURA_2000_percent			-,546	
Ozone_conc_exceed				,961
Waste_water_treat_perc		-,697		
Soil_sealed_area_perc			,858	

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Factor 1 seems related to Unemployment, as the variables highly correlated to this factor are the total unemployment, long-term unemployment and youth-unemployment rates. This factor explains 24.19% of the total system's variance.

The geographical distribution of this factor's scores (Figure 70) shows a concentration of the highest values in the more depressed areas of Europe, and particularly in countries with structurally high unemployment rates such as (e.g. Southern Italy and Spain, Eastern Germany, Slovakia and Greece). Regions which used to have a strong industrial base, also illustrate relatively high scores in this factor, namely some regions in northern France and Portugal, Wallonia, the Setúbal Peninsula, Liverpool and Manchester.

In some borders, the regions seem to have higher scores in this indicator than the more centrally located regions. This is the case in Portugal, on the northern border of France and Bulgaria, Finnish Karelia or the Czech Republic, where it borders with eastern Germany.

Focusing in the Greece – Bulgaria CBA, we find relatively high positive factor score values in all Anatoliki Makedonia, Thraki (GR11) NUTS3 areas and in Smolyan (BG424, +0.28). All other areas depict negative factor scores, implying a negative unemployment trand. A similar pattern is seen when comparing each NUTS3 areas factor score to the national average (BG = -0.40; GR = 0.40). All Bulgarian CBA's areas score below the national average while in Anatoliki Makedonia, Thraki only Xanthi (GR112, -0.07) and Rodopi (GR113, -0.23) score below the Greek national level. Drama (GR114, +1.74) has the highest unemployment record of the CBA.

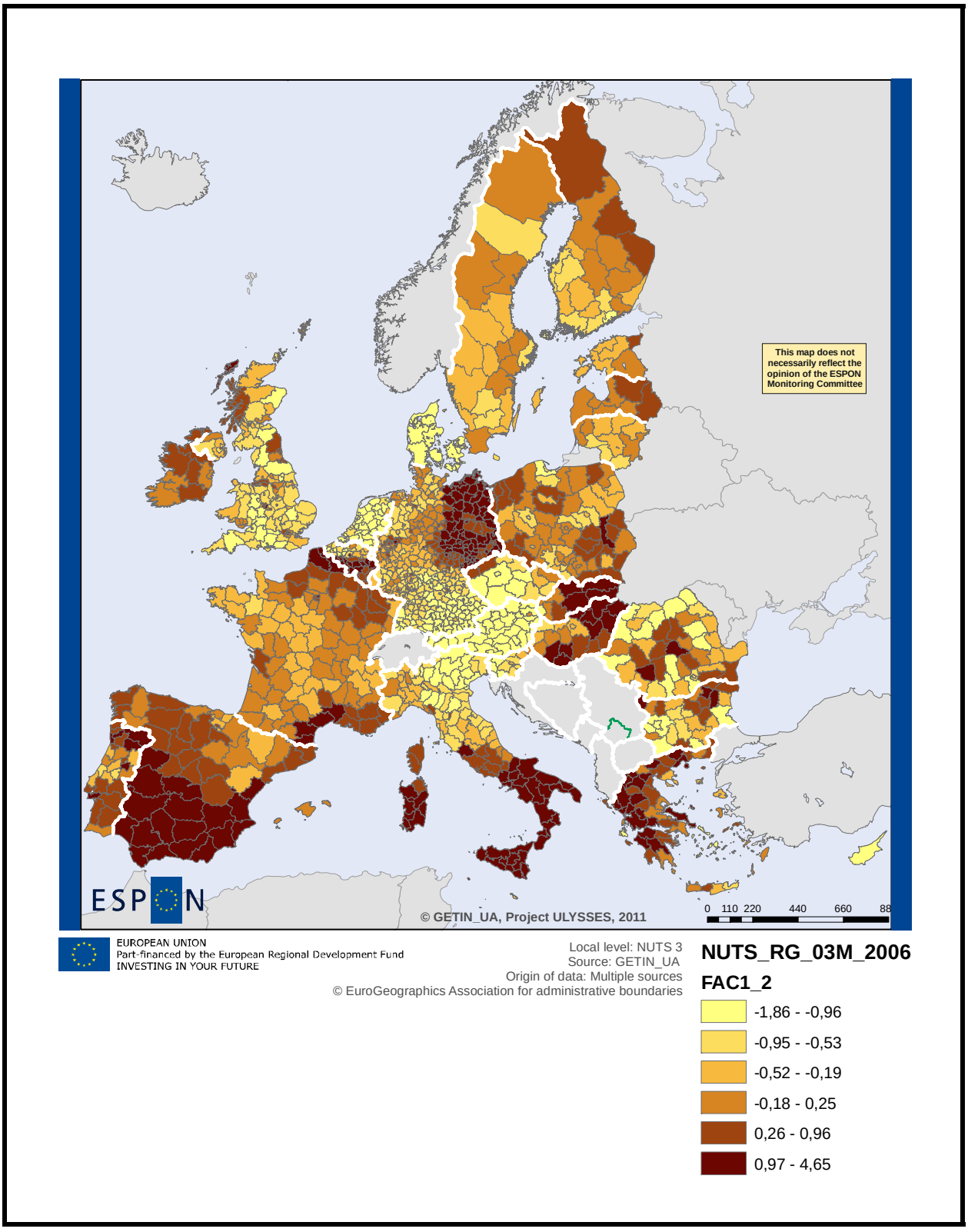

Figure 70. Spatial distribution of rotated factor scores for factor 1 representing 'unemployment'.

Table 63. Factor scores for Factor 1 (unemployment) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 1						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	0.07						80
BG	Bulgaria	-0.40				-0.48		50
GR	Greece	0.40				0.32		80
BG411	Sofia (stolitsa)	-1.26	-0.85			-1.33	- -	20
BG412	Sofia	-1.19	-0.79			-1.26	- -	20
BG413	Blagoevgrad	-1.36	-0.95			-1.43	- -	5
BG414	Pernik	-0.98	-0.58			-1.05	- -	20
BG415	Kyustendil	-0.08	0.32			-0.15	- +	80
BG421	Plovdiv	-0.79	-0.38			-0.86	- -	50
BG422	Haskovo	-0.52	-0.12			-0.59	- -	50
BG423	Pazardzhik	-0.54	-0.14			-0.61	- -	50
BG424	Smolyan	0.28	0.69			0.21	+ +	80
BG425	Kardzhali	-1.11	-0.71			-1.19	- -	20
GR111	Evros	0.76		0.37		0.69	+ +	95
GR112	Xanthi	0.33		-0.07		0.26	+ -	80
GR113	Rodopi	0.17		-0.23		0.09	+ -	80
GR114	Drama	2.14		1.74		2.06	+ +	> 95
GR115	Kavala	1.19		0.79		1.12	+ +	95

Performing a regression analysis of factor 1 variables with those representing the territorial profile factors, it is possible to see that, although the overall variation explained by this factor is small, its relation to most of them is statistically significant (Table 64). The coefficients indicate that the high levels of unemployment have a strong negative relation to the high investments in R&D, the demographic dynamism and the high levels of immigration. On the other hand, areas with high levels of unemployment are positively associated with public administration centers and increased construction activity.

Table 64. Regression analysis results between territorial performance factor 1 (unemployment) and all territorial profile factors.

Regression Statistics	
Multiple R	0,59374
R Square	0,35252
Adjusted R Square	0,34699
Standard Error	0,80809
Observations	1298

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower*	*Upper*
Intercept	-3,4E-09	0,022430	-1,5E-07	1	-0,0440	0,0440	-0,0440	0,0440
FAC1_1	-0,13913	0,022438	-6,20045	7,57172E-10	-0,1831	-0,0951	-0,1831	-0,0951
FAC2_1	-0,17056	0,022438	-7,60142	5,62205E-14	-0,2146	-0,1265	-0,2146	-0,1265
FAC3_1	0,35445	0,022438	15,79682	1,64522E-51	0,3104	0,3985	0,3104	0,3985
FAC4_1	-0,17954	0,022438	-8,00162	2,72054E-15	-0,2236	-0,1355	-0,2236	-0,1355
FAC5_1	-0,01938	0,022438	-0,86369	0,387920516	-0,0634	0,0246	-0,0634	0,0246
FAC6_1	0,04804	0,022438	2,140949	0,032465709	0,0040	0,0921	0,0040	0,0921
FAC7_1	-0,12934	0,022438	-5,76408	1,02676E-08	-0,1734	-0,0853	-0,1734	-0,0853
FAC8_1	0,07384	0,022438	3,29098	0,001025468	0,0298	0,1179	0,0298	0,1179
FAC9_1	-0,16827	0,022438	-7,49914	1,19255E-13	-0,2123	-0,1242	-0,2123	-0,1242
FAC10_1	-0,29276	0,022438	-13,0475	1,24326E-36	-0,3368	-0,2487	-0,3368	-0,2487
FAC11_1	-0,08551	0,022438	-3,81081	0,000145058	-0,1295	-0,0415	-0,1295	-0,0415

Factor 2 refers to the convergence dynamism of each NUTS3 area of the EU27 space to the leading region (London NUTS2), since it is related to the GDP and the GDP growth in the period 1997 – 2008. Its correlated variables also include urban waste water treatment capacity and infant mortality. This factor explains 18.71% of the total system's variance.

As can be seen in the map (Figure 71), the correlation between high GDP growth and poor social conditions is essentially a consequence of the very high growth rate witnessed by the eastern European countries throughout the late 1990 and early 2000 (some countries even had occasional double digit growth rates), while the central European countries, although starting from a high initial position, witnessed relatively small growth rates. The overall pattern of the border regions seem to essentially follow the national tendency.

In the Greece – Bulgaria CBA all NUTS3 areas show a convergence tendency,with the Bulgarian areas having stronger trends, and the Greek areas with lower factor scores (Table 65). Most Anatoliki Makedonia, Tharki areas score above the Greek national convergence level (only Evros, GR111 scores negatively). On the contrary, all Bulgarian areas score below the national average level, apart of Smolyan (BG424, +0.10). When comparing the CBA areas to the CBR mean convergence score, it occurs that all Bulgarian areas are above this mean level, while all Greek areas are below the mean CBR level.

Table 65. Factor scores for Factor 2 (convergence dynamism) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 2						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	0.98						95
BG	Bulgaria	2.43				1.44		> 95
GR	Greece	0.00				-0.98		80
BG411	Sofia (stolitsa)	2.08	-0.34			1.10	+ -	95
BG412	Sofia	1.74	-0.69			0.76	+ -	95
BG413	Blagoevgrad	1.52	-0.91			0.54	+ -	95
BG414	Pernik	2.02	-0.41			1.03	+ -	95
BG415	Kyustendil	1.39	-1.04			0.40	+ -	95
BG421	Plovdiv	2.38	-0.05			1.40	+ -	> 95
BG422	Haskovo	2.22	-0.21			1.24	+ -	95
BG423	Pazardzhik	2.39	-0.03			1.41	+ -	> 95
BG424	Smolyan	2.53	0.10			1.54	+ +	> 95
BG425	Kardzhali	2.29	-0.14			1.31	+ -	95
GR111	Evros	-0.06		-0.06		-1.04	- -	80
GR112	Xanthi	0.23		0.23		-0.75	- +	80
GR113	Rodopi	0.62		0.62		-0.36	- +	95
GR114	Drama	0.67		0.67		-0.31	- +	95
GR115	Kavala	0.24		0.24		-0.74	- +	80

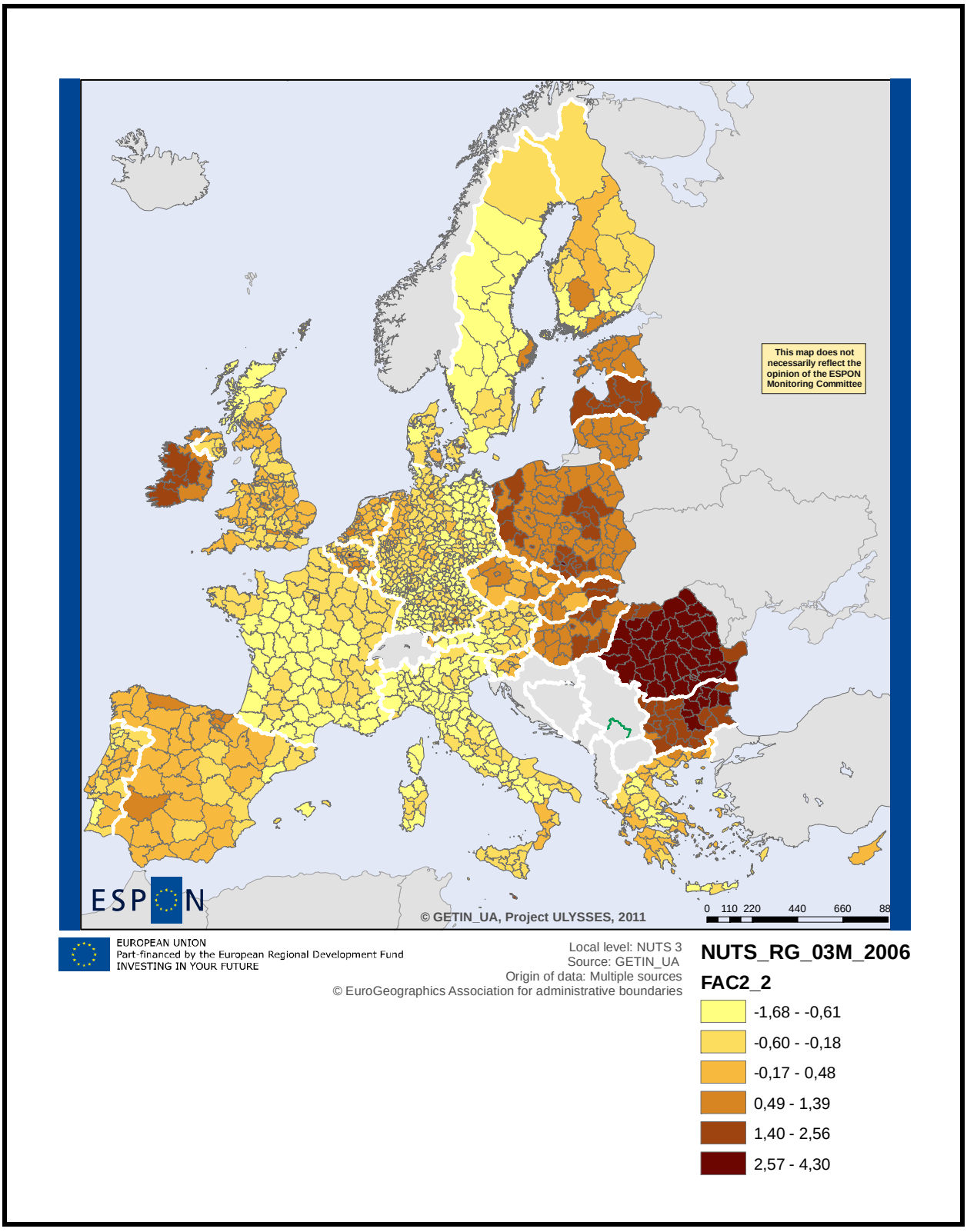

Figure 71. Spatial distribution of rotated factor scores for factor 2 representing 'convergence dynamism'.

As explained above, the negative correlation of the convergence indicator with other performance indicators in this factor is essentially linked to the high growth rates of the eastern countries in the initial decades of their transition to a market economy. As this is an historic contingency and does not follow a deeper causal nexus, the regression analysis was made only for the convergence indicators.

The regression of this indictor, which showed a slightly higher R square then the previous one, shows that it is statistically related to many components of the territorial profile. Confirming what has previously been said about this indicator, the catching up process is especially strong in eastern countries and therefore the highest negative coefficients occur in factor 1 (centrality) and factor 3 (public administrative centres). On the other hand, in central Europe the regions which perform best in this indicator are the ones located in the 'blue banana' and, even in Eastern Europe, the top performing regions tend to be the more central ones. This might explain why the catching-up process is also negatively related to rurality (factor 9 - low density and growth of agricultural areas).

Table 66. Regression analysis results between territorial performance factor 2 (convergence dynamism) and all territorial profile factors.

Regression Statistics	
Multiple R	0,6261119
R Square	0,3920161
Adjusted R Square	0,3868156
Standard Error	0,7830609
Observations	1298

	Coefficients	*Standard*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower*	*Upper*
Intercept	-6,26829E-08	0,0217	-2,884E-06	0,9999977	-0,043	0,043	-0,043	0,043
FAC1_1	-0,352	0,0217	-16,197241	7,7102E-54	-0,395	-0,310	-0,395	-0,310
FAC2_1	-0,102	0,0217	-4,7047433	2,8164E-06	-0,145	-0,060	-0,145	-0,060
FAC3_1	-0,326	0,0217	-14,995851	5,713E-47	-0,369	-0,283	-0,369	-0,283
FAC4_1	0,053	0,0217	2,4167366	0,01579882	0,010	0,095	0,010	0,095
FAC5_1	0,140	0,0217	6,44670648	1,6131E-10	0,098	0,183	0,098	0,183
FAC6_1	0,091	0,0217	4,18168723	3,0895E-05	0,048	0,134	0,048	0,134
FAC7_1	0,042	0,0217	1,9210766	0,05494291	-0,001	0,084	-0,001	0,084
FAC8_1	-0,049	0,0217	-2,2370838	0,02545166	-0,091	-0,006	-0,091	-0,006
FAC9_1	-0,297	0,0217	-13,645679	1,0773E-39	-0,339	-0,254	-0,339	-0,254
FAC10_1	-0,168	0,0217	-7,7085769	2,5325E-14	-0,210	-0,125	-0,210	-0,125
FAC11_1	0,017	0,0217	0,78598351	0,43202194	-0,026	0,060	-0,026	0,060

Factor 3 refers to economic development of the NUTS3 areas of the EU27 space. The indicators positively correlated to this factor are the GDP per capita and the percentage of soil sealed area, while the coverage by Natura 2000 sites is negatively correlated by this factor. It can therefore be understood as a factor which expresses high degrees of development and urbanization. As expected, the regions with the highest scores on this factor are concentrated in central Europe and Scandinavia and also include the capital cities of more marginal countries (Figure 72). This factor explains 17.57% of the total system's variance.

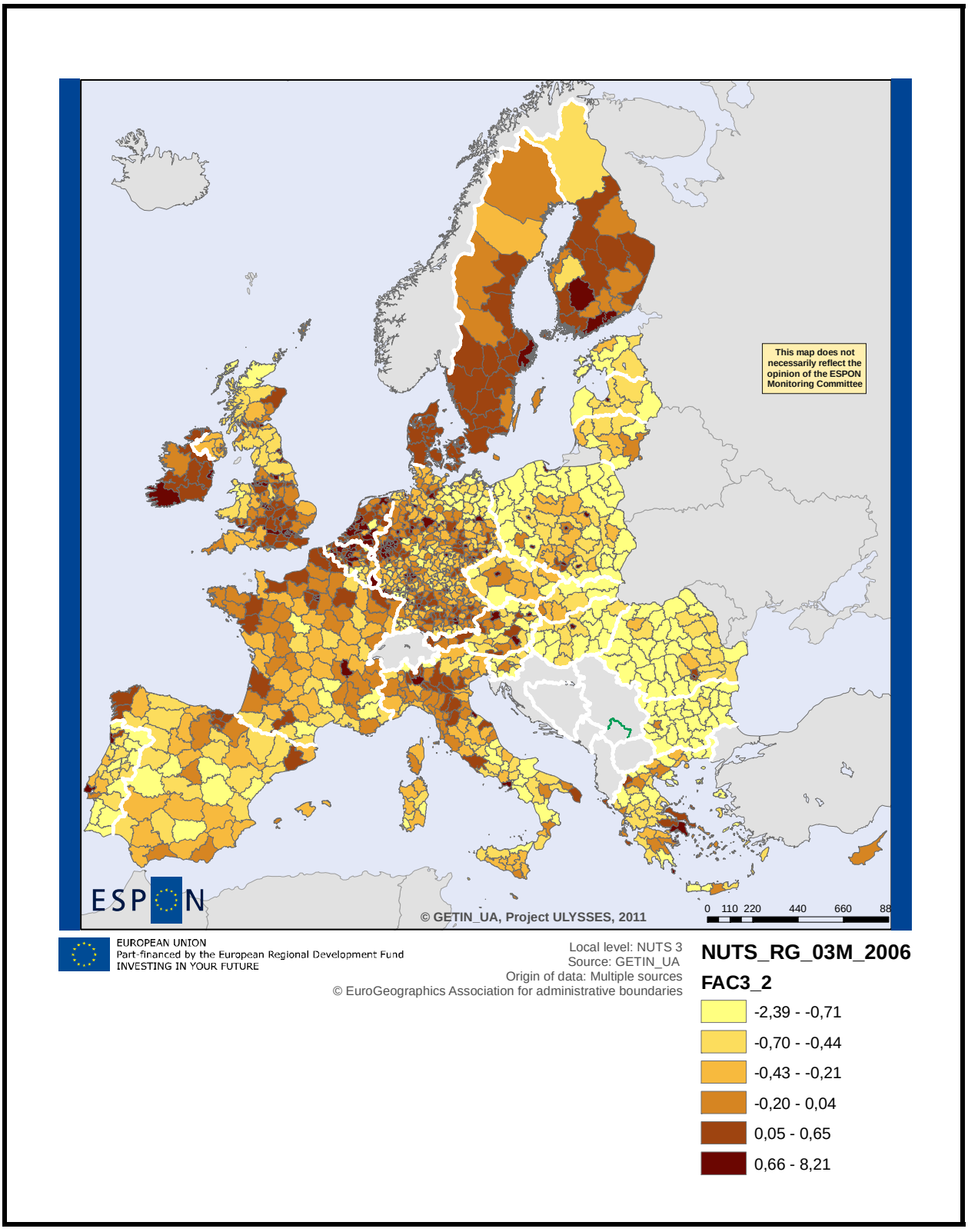

Figure 72. Spatial distribution of rotated factor scores for factor 3 representing 'economic development'.

All NUTS3 areas of the Greece – Bulgaria CBA have negative scores in the factor of economic development, as related to the EU27 space (Table 67). Similar negative outlook is also seen at national level (BG = -1.20; GR = -0.03). Compared to the national average economic development, most areas score below this level, with the exception of Sofia stolitsa (BG411, +1.20) and Pernik (BG414, +0.10). Evros (GR111) is the area with the lowest economic performance in Anatoliki Makedonia, Thraki.

Table 67. Factor scores for Factor 3 (economic development) of NUTS3 areas of the Greece – Bulgaria CBA.

NUTS code	NUTS name	FACTOR 2						
		Scores	Country comparison (weighted NUTS 3 average)				CBR / country level (+ -)	Percentile all NUTS 3
CS3			BG	GR		All CBR countries		
All	All Countries	-0.50						50
BG	Bulgaria	-1.20				-0.70		5
GR	Greece	-0.03				0.47		80
BG411	Sofia (stolitsa)	0.01	1.20			0.51	+ +	80
BG412	Sofia	-1.60	-0.40			-1.10	- -	5
BG413	Blagoevgrad	-2.01	-0.82			-1.51	- -	5
BG414	Pernik	-1.09	0.10			-0.59	- +	20
BG415	Kyustendil	-1.64	-0.44			-1.14	- -	5
BG421	Plovdiv	-1.40	-0.20			-0.90	- -	5
BG422	Haskovo	-2.00	-0.81			-1.50	- -	5
BG423	Pazardzhik	-1.86	-0.66			-1.36	- -	5
BG424	Smolyan	-1.64	-0.45			-1.14	- -	5
BG425	Kardzhali	-1.88	-0.69			-1.38	- -	5
GR111	Evros	-1.22		-1.19		-0.72	- -	5
GR112	Xanthi	-0.74		-0.71		-0.24	- -	20
GR113	Rodopi	-0.93		-0.91		-0.44	- -	20
GR114	Drama	-0.27		-0.25		0.23	+ -	50
GR115	Kavala	-0.42		-0.39		0.08	+ -	50

The explanatory capacity of this regression is significantly higher than that of the previous factors expressing the territorial performance of NUTS3 areas (Table 68). The coefficients, once again, show a significant relation with most of the factors of the territorial profile. The overall picture from the coefficients is a positive effect from factors related to centrality and R&D investments (factor 1 and 2 of territorial profile). It is also interesting to see that the central location explains much more of different economic development levels than the investment in R&D. Similar conclusions can be drawn from the highly negative coefficient of the indicator related to rurality (factor 9) meaning that, on themselves, density and central location seem to be more important than research and innovation. The weight of the construction sector is also considerably negative, probably meaning that, at a certain stage, high economic development is more linked to a strong service sector (factor 3) than infrastructural development (factor 8).

Table 68. Regression analysis results between territorial performance factor 3 (economic development) and all territorial profile factors.

Regression Statistics	
Multiple R	0,824258
R Square	0,679401
Adjusted R Square	0,676659
Standard Error	0,568631
Observations	1298

	Coefficients	*Standard*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower*	*Upper*
Intercept	-1E-07	0,01578	-7,1E-06	0,999994301	-0,0310	0,0310	-0,0310	0,0310
FAC1_1	0,4545	0,01579	28,78786	4,4844E-141	0,4236	0,4855	0,4236	0,4855
FAC2_1	0,1623	0,01579	10,27749	7,24251E-24	0,1313	0,1932	0,1313	0,1932
FAC3_1	0,0837	0,01579	5,303401	1,33687E-07	0,0528	0,1147	0,0528	0,1147
FAC4_1	0,0844	0,01579	5,348225	1,05025E-07	0,0535	0,1154	0,0535	0,1154
FAC5_1	0,1545	0,01579	9,785094	7,39012E-22	0,1235	0,1855	0,1235	0,1855
FAC6_1	0,0372	0,01579	2,356502	0,018597296	0,0062	0,0682	0,0062	0,0682
FAC7_1	0,1029	0,01579	6,518061	1,02027E-10	0,0719	0,1339	0,0719	0,1339
FAC8_1	-0,3541	0,01579	-22,4252	2,83549E-94	-0,3851	-0,3231	-0,3851	-0,3231
FAC9_1	-0,5195	0,01579	-32,9051	8,784E-173	-0,5505	-0,4886	-0,5505	-0,4886
FAC10_1	-0,0122	0,01579	-0,7752	0,438363708	-0,0432	0,0187	-0,0432	0,0187
FAC11_1	-0,0321	0,01579	-2,03075	0,042485717	-0,0630	-0,0011	-0,0630	-0,0011

Factor 4 of the territorial performance analysis seems related to pollution, as the positively correlated component is the ozone concentration exceedance. At the same time, this factor indicates areas with strong urban and industrial profile, as ozone concentration is related to a photo-chemical reaction of pollutants and depends on the presence/absence of heavy industries, traffic levels, sun exposure but also on wind conditions.

This means that emissions in one place can affect neighbouring regions, that high emission in southern countries will lead to higher ozone levels than in northern countries and that favourable wind conditions can lead to low levels in regions with high emissions and vice-versa. Therefore, a regression analysis of this indicator with the context factors has necessarily a very limited explanatory capacity and can lead to relations that lack any evident logic if the atmospheric conditions are not taken into account. Although the map shows as some overall tendencies (Figure 73), the regression analysis shouldn't be taken into account.

There also seem to be some discrepancies on the way it is measured in different countries, as it is not plausible that there are so clear cuts on some borders, such as can be seen in Ireland.

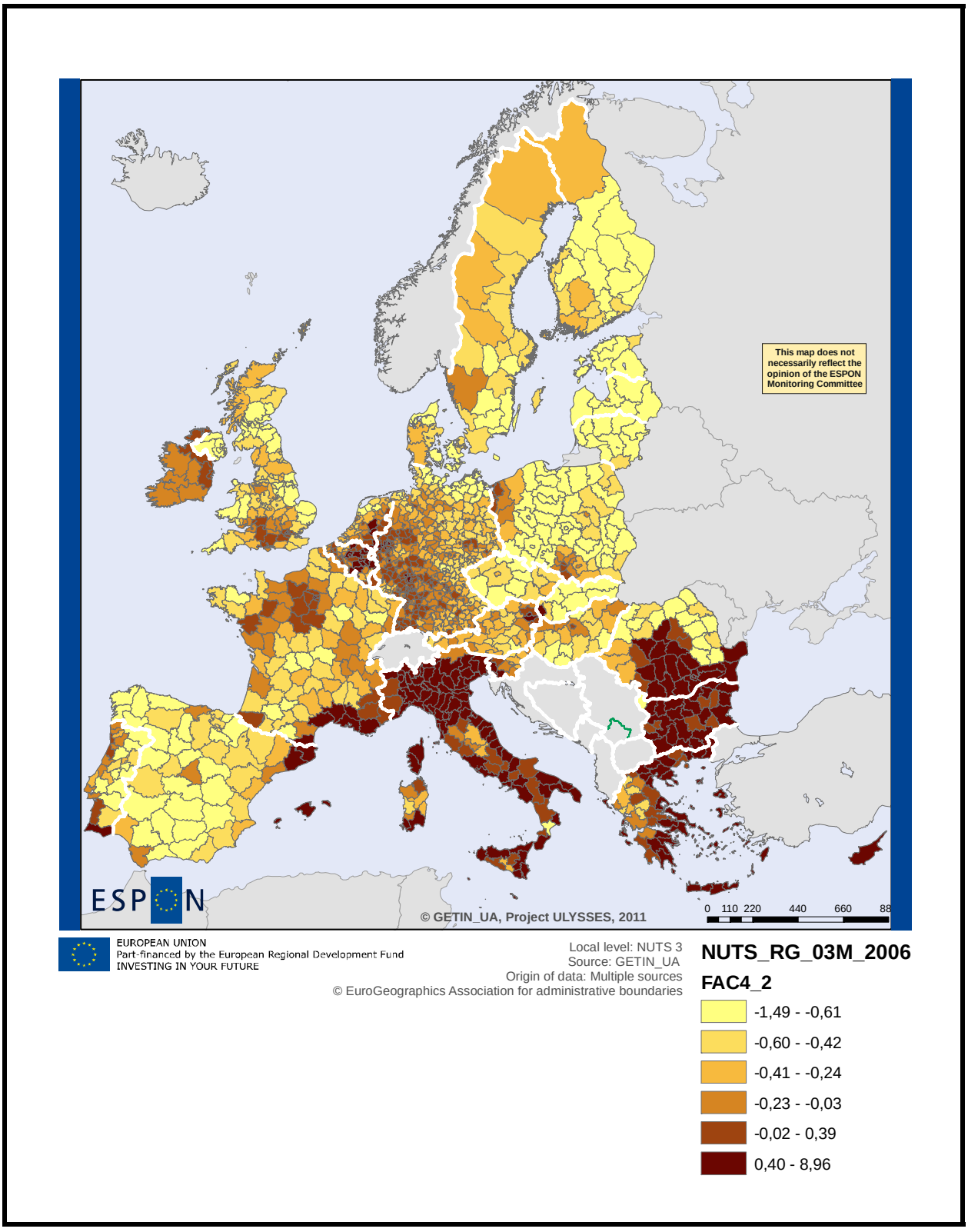

Figure 73. Spatial distribution of rotated factor scores for factor 4 representing 'air pollution'.

7.4. Chapter conclusions

- Extended datasets on indicators related to the themes examined in previous chapters (as demography, accessibility, rural-urban relationship and Lisbon/Gothenburg/Europe 2020 indicators), for year 2008 of the NUTS3 areas throughout the EU27 space, were further analysed using factor analysis aiming to explore the relations between regions' territorial profile and the region's performance.
- Territorial profile analysis illustrated that there exist eleven main factors, explaining approximately 74% of total system's variance. Based on this analysis, the Greece – Bulgaria CBA seems unfavoured by its position, being characterised as a peripheral region in the EU27 space. It shows low demographic dynamism, mostly due to negative population growth rates rather than immigration. Trade, tourism and transport are the main sectors affecting local CBA's economy. Anatoliki Makedonia, Thraki (GR11) could be identified as a public administration centre of the CBA, in terms of employment and the GVA produced. The area lacks investments in the research and development sector while appears as a rather sensitive to climate change risks area.
- The above territorial profile affects significantly the territorial performance of the CBA. The area suffers by high unemployment (especially in Anatoliki Makedonia, Thraki) and limited economic development, showing a strong convergence tendency of all Bulgarian areas. Territorial performance analysis indicated that these high unemployment levels are strongly related to the low R&D investments, the limited demographic dynamism and the high levels of immigration. Poor economic convergence seems related to the low centrality of the region and the increased public administration sector. Central location appears a more important factor to support economic development of a region, than R&D investments.

Chapter 8 – Conclusions

The present report comprises a multi-scale and multi-thematic analysis to assess territorial socioeconomic dynamics and performances of the Greece – Bulgaria Cross-Border Area (CBA) and identify territorial drivers and profiles. The CBA extends at the NE part of Greece and the S part of Bulgaria, consisting of three administrative regions: Yugozapaden (BG41), Yuzhen tsentralen (BG42) and Anatoliki Makedonia, Thraki (GR11). CBA's total population represents approximately 0.85% of EU27 population, decreasing during the latest decade by 4.3%, due to both natural causes and net migration. Xanthi and Sofia stolitsa are the only areas of the CBA experiencing population growth, at even higher rates than EU27 growth rate. Increase in former area is attributed to net migration, while in the latter area to natural increase. Population decrease is mostly attributed to the low mean fertility rate recorded in the CBA. Although fertility rate gradually increases over the latest decade, its value appears significantly lower than the corresponding EU27 rate. Anatoliki Makedonia, Thraki exhibits the highest fertility rate in the CBA, of similar order to the EU27 value. At the same time, the area depicts an over-aging behaviour, having higher aged-population share as compared to the young population of the CBA. Population distribution is rather similar to the EU27 mean value, but shows strong disparities among NUTS3 areas, with higher population densities near urban conglomerates. Along wellestablished transportation axes, the border seems to attract population, affecting its density and growth patterns. On the contrary, newly opened crossings do not seem to affect borderline settlements.

Sixteen Functional Urban Areas exist in the Greece – Bulgaria CBA, with Sofia (stolitsa) being the main urban centre dominating the region. Over the years, Sofia's population primacy appears increasing, although the CBA exhibits a rather polycentric pattern in its population distribution. Overall, the population primacy of Sofia over the rest FUAs of the CBA is rather moderate and significantly lower than the corresponding Athens and Thessaloniki primacy over Greece and Voreia Ellada, respectively. On the other hand, Sofia's economic primacy over the remaining CBA is weak to moderate, implying a more polycentric economic development over the cross-border territory. When examining the settlements' relative distance and structure over the CBA, it occurs that most areas are considered as polycentric over their region of influence, and only Sofia, Pernik, Plovdiv, Asenovgrad and Pazardzhik could be characterised as monocentric. Accessibility characteristics of the CBA suggest that most FUAs exhibit limited accessibility changes, because of population change. Again, Sofia is the dominant FUA in terms of accessibility over the remaining CBA, with all other areas displaying a rather homogeneous pattern.

Urban-rural analysis involved the identification of CBA's NUTS3 areas according to population density, urban-to-rural population shares, employment and GVA produced by the primary sector and land type coverage. Population density decreases over the latest decade, due to strong depopulation, with projections forecasting that by year 2020 the CBA would be considered as a 'strongly rural area'. Sofia stolitsa is the only 'strongly urban area' of the CBA while Plovdiv the only 'moderately urban area'. Over the last five years a gradual increase in urbanism has occurred in the CBA, mostly shown by the sharp decrease of population employed in Agriculture, Forestry and Fishing sector and it's produced GVA. Anatoliki Makedonia, Thraki shows the highest drop in these indicators, following the general national trend. This 'urbanization' tendency of the CBA is also accompanied by a subsequent transformation of agricultural areas into artificial areas. Following the existing Eurostat typology on urban-rural characterization, Sofia stolitsa (BG411) is classified as a 'Predominantly Urban Area'; Kyustendil (BG415), Pernik (BG414), Plovdiv (BG412) and Haskovo (BG422) as 'Intermediate Areas', and all remaining regions as 'Predominantly Rural Areas'. According to ESPON 1.1.2 typology the whole Anatoliki Makedonia, Thraki (GR11) and the regions of Blagoevgrad (BG413), Smolyan (BG424) and Kardzhali (BG425) are areas of 'Low Urban Influence and Low Human Intervention'; Haskovo (BG422), Pazardzhik (BG423), Sofia (BG412) and Pernik (BG414) are characterised as areas of 'Low Urban Influence and Medium Human Intervention', while Sofia stolitsa (BG411) and Plovdiv (BG412) are considered as areas of 'High Urban Influence and High Human Intervention'.

Accessibility and connectivity analysis was performed aiming to determine the general accessibility levels of the Greece – Bulgaria CBA according to the various transportation modes, i.e., road, rail and air, as well as multi-modally. Potential accessibility by road of Yugozapaden (BG41) and Yuzhen tsentralen (BG42) (34.38 and 32.56, respectively) appeared significantly higher than that of Anatoliki Makedonia, Thraki (GR11, 21.6), although the latter shows strong infrastructure improvement. Sofia stolitsa (BG411), Plovdiv (BG421) and Haskovo (BG422) acquired the highest potential accessibility by road indices, while Evros (GR111) and Drama (GR114) the lowest. A similar pattern to road accessibility was also shown in the potential accessibility by rail index. Sofia stolitsa (BG411) and Pernik (BG414) show the highest potential accessibility score, while Evros (GR111), Kardzhali (BG425) and Kyustendil (BG415) demonstrate the lower values. Yugozapaden (BG41) depicts the higher potential accessibility by air, almost double than that of Anatoliki Makedonia, Thraki (GR11) and Yuzhen tsentralen (BG42). The multimodal index of Yugozapaden (BG41) appeared significantly higher than the remaining area. Rodopi (GR113) and Kyustendil (BG415) experienced the strongest accessibility improvement, mostly attributed to rail accessibility upgrading. Improvement in the remaining Yugozapaden seems related to air accessibility change. Intermediate improvement is seen in the remaining Yuzhen tsentralen (BG42), mostly attributed to rail and air accessibility changes. Finally,

only Kardzhali (BG425) showed an opposite behaviour, due to negative change in road and rail accessibility indices and the limited air accessibility improvement.

The territorial performance of the Greece – Bulgaria CBA according to the Lisbon/Gothenburg indicators was examined, focusing on the sectors of economic growth, employment, research and innovation, economic reform, social cohesion and the environment. Indexed GDP per capita analysis revealed that the CBA could be characterised as 'less developed to very laggard region', scoring at the low level rankings of EU27 areas. Convergence analysis demonstrated that Kavala (GR115), Xanthi (GR112) and Evros (GR111) are 'non-converging areas', in terms of GDP per capita trends. Kyustendil (BG415), Rodopi (GR113) and Drama (GR114) are considered as 'slow converging areas', while Sofia stolitsa (BG411), Pernik (BG414) and Smolyan (BG424) are considered as 'steady catching-up areas'. Employment in the CBA seems distributed rather evenly among all NACE economic activities, exhibiting a slight annual rise of 0.73% over the last decade. This increase seems attributed to the construction and the financial and real estate sector. The reduction in the employment in the primary sectors is apparent. Wholesale and retail trade, tourism and transport sector, among with the financial and real estate sector are the higher contributors to CBA's GVA. Construction and public administration services increased their shares over the latest decade. Social cohesion indicators, as total, long-term and youth unemployment rates are generally higher than the corresponding mean EU27 values. Similarly, the Population at Risk of Poverty Index is well above the EU27 level, and only infant mortality seems comparable to the correspondent EU27 standard. All social cohesion indicators gradually improved during the 1997-2008 period. After 2008, due to the global financial crisis, all indicators degraded sharply, returning to the 1997 levels.

Territorial profile analysis revealed that the lack of central CBA's location over the EU27 space is a major disadvantage. Demographic trends are negative, mostly due to natural causes rather than immigration rates. Trade, tourism and transport are the main economic sectors supporting local CBA's economy. Anatoliki Makedonia, Thraki (GR11) could be identified as a public administration centre of the CBA, in terms of employment and the GVA produced. The area lacks investments in the R&D sector, while appears as rather sensitive to climate change and environmental risks. Territorial performance analysis of the CBA indicated that the area suffers from high unemployment (especially in Anatoliki Makedonia, Thraki) and limited economic development, showing a strong convergence tendency of all Bulgarian areas. Overall, area's poor economic performance seems related to its low centrality, the exaggerated public administration sector, the low R&D investments and the limited demographic dynamism.

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