Geography of socio-economic differentiation of Poland according to subregions in 2002–2014

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ABSTRACT
The paper focuses on the territorial differentiation of socio-economic development of Poland between the years 2002–2014 and on geographic patterns of this differentiation according to the subregions ('podregiony' in Polish, NUTS 3 level). Eight partial indicators entering the composite indicator and also the average base index are applied. The analysis of the socio-economic development of the subregions along the directional east-west gradient, rural-urban concentric gradients (around big cities) and the zones of subregions along the border of Poland with the surrounding countries are used to explain the observed differentiation. Polish subregions have undergone considerable development between 2002 and 2014, but the territorial differentiation of their development has changed only partially. The big Polish cities and also their suburban subregions have the best position of all; the worst are still the rural subregions of eastern Poland and the inner peripheries of Poland. The directional east-west gradient, the rural-urban concentric gradients, as well as the higher development of subregions at German, Czech and sea borders were confirmed.

KEYWORDS
regional differentiation; regional disparities; regional development; regional gradient; Poland

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1. Introduction

Poland is a big Central European post-socialist country in terms of area and population. The country is located on the boundary of Central Europe, developed North Europe and less developed post-socialist Eastern Europe. Especially across the Polish-German, Baltic Sea and Polish-Czech border, the country is connected to the developed countries of Europe. Poland is predominantly a lowland country, so the orographic factors play rather a peripheral role in the socio-economic development of the regions of Poland. The Polish settlement-regional system, unlike the Czech Republic or Hungary, is quite polycentric due to the existence of several 'half-million' cities (nevertheless almost two million Warsaw dominates in this system) and is somewhat territorially unbalanced because of the cities of the urban conurbation in Upper Silesia (Konurbacja górnośląska) in southern Poland.

The differences in the socio-economic development of Polish big cities (and their near suburban hinterlands) on one side and their remote peripheral rural hinterlands on the other hand are, according to many authors, significant – Churski (2010), Śleszyński et al. (2017) and others. There are still historically conditioned differences between the more developed western part of Poland (belonging to 1918 Prussia/Germany) and its less developed eastern part (belonging to Russia and Austria-Hungary to 1918) – Zimon (1979), Zarycki (2007), Nováček (2014) and others. This east-west gradient also manifests itself in other post-socialist countries of Central Europe – Downes (1996), Enyedi (2011) in Hungary, Korec (2009) in Slovakia or Blažek, Csank (2005) in Czechia. The existence of this gradient is also transmitted to the lower development of Polish border areas along the northeastern, eastern and southeastern border of Poland – Gorzelak (1998) or Chidlow et al. (2009).

In the 1990s, during the transformation of the society and the economy, differences in the level of development of the Polish regions began to increase – Stryjakiewicz (2009), Churski, Borowczak (2013) and many others. This is also valid in other Central European post-socialist countries – Petrakos (2001) or Kilijoniene et al. (2010). Especially regions with major cities and regions along the western border of these countries developed well in this period. Polish voivodships ('województwa' in Polish; NUTS 2 level) are grouped around big and medium-sized cities. Their size and method of delimitation (these are the large catchment regions of such cities) do not allow for the disparities between these cities and rural areas. This is possible, to a certain extent, according to the Polish subregions ('podregiony' in Polish; NUTS 3 level).

The aim of the article is *to uncover and explain the territorial socio-economic differentiation inside Poland and changes of this differentiation between 2002 and 2014 according to the subregions (NUTS 3) using the socio-economic indicators for these subregions*. The view of this differentiation and its development will be the subject of the first research question (1). Differences in the socio-economic development of subregions along *rural-urban concentric gradients* in the years under review will be analysed in the second research question (2). A greater degree of development in urban subregions and lesser in rural subregions can be expected (see the literature above). Literature often refers to the socio-economic underdevelopment of the eastern regions of Poland, respectively *east-west developmental gradient of Poland* (see the literature above). This issue will be monitored according to the subregions through a third research question (3). The fourth research question focuses on the differences in the socio-economic development of the *state-border subregions* in the zones along the border of Poland with individual neighbouring countries and the Baltic Sea (4). We can assume that the Polish subregions are less developed along the Polish-Ukrainian and Polish-Belarusian borders thanks to the mentioned east-west gradient and also due to the low permeability of this border now and in the past. Specific methods of analysis for research questions 1–4 will be developed.

2. Socio-economic differentiation of Polish regions in literature and input assumptions

Many Polish and other authors, especially in the period around Poland's accession to the EU in 2004 and beyond, revealed *territorial socio-economic differentiation within Poland and its changes* (the first research question) in their studies; e.g. Czyż (2002), Churski (2010) and others, while changes in this differentiation were observed by Stryjakiewicz (2009), Kilijoniene et al. (2010) or Churski, Borowczak (2013). Some put more emphasis on justifying this differentiation and its changes – Gorzelak (1998), Ferry (2004), Lobatch (2004), Churski (2005), Zientara (2008) or Chidlow et al. (2009). Such studies were almost always processed according to the Polish voivodships. Some of them had a broader territorial scope when they were also interested in Poland and also other countries in post-socialist Central and Eastern Europe – Barjak (2001), Petrakos (2001), Vošta (2004), Kilijoniene et al. (2010), Skokan (2011) or Tvrdoň, Skokan (2011).

Growth of the socio-economic development along the *rural-urban concentric gradients in Poland* (2) is mentioned by Barjak (2001), Domański (2003), Ferry (2004), Lobatch (2004), Stryjakiewicz (2009), Churski (2010), Churski, Borowczak (2015) or Kovács et al. (2015). Dolata, Borowczak (2014) found that in the western part of Poland these gradients are less pronounced than in the eastern part. The core position of Warsaw as the capital city in Poland is

underlined by Czyż (2002), Churski (2005) or Kilijoniene et al. (2010). *The east-west gradient of the socio-economic development of Polish regions* (3) deepened in the period of the Industrial Revolution, slightly diminished in the orientation period of the Central European countries to the Soviet Union and has deepened again after 1989. The presence of this gradient was written about by Surazska et al. (1997), Petrakos (2001), Vošta (2004), Lobatch (2004), Churski (2005), Stryjakiewicz (2009), Zdražil, Kraftová (2012) and Churski, Borowczak (2013). Ferry (2004) saw this gradient somewhat turned in the north-southwest direction.

The previous issue is connected to another geographic pattern of socio-economic development of the Polish regions – *the smaller development of the regions located along the eastern state border of Poland* (4) compared to the regions at the state border with Germany. That is caused due to the proximity of developed Germany and other Western European countries and the favourable influence of German and other Western European companies on these Polish border regions – see e.g. Chidlow et al. (2009) or Stryjakiewicz (2009).

In addition to these geographic models of socio-economic differentiation of regions, other local factors apply in Poland. For example, the presence of the hi-tech industry (Barjak 2001; Lobatch 2004; Churski 2005; Churski, Borowczak 2013) or large universities and tertiary educated population (Barjak 2001; Ferry 2004; Chidlow et al. 2009). The presence of highways and their intersections (Nováček 2014) or major seaports (Petrakos 2001; Chidlow et al. 2009) is important. Other authors mapped the quality of the social capital of the Polish regions. The positive influence of social capital, measured by various social and cultural (in Poland also Church) activities on the economic development of the regions, leads to disputes (Zarycki 2007). The heavily polluted atmosphere in Upper Silesia (Churski 2010) or the existence of declining mining and metallurgical Polish industries (Lobatch 2004; Churski 2005) is detrimental to the socio-economic development of these regions. The high altitude or great diversity of the relief may also be unfavourable – in the borderland with Czechia (Sudety Mountains) and Slovakia (Carpathian Mountains).

In the theory of regional policy and development the question of whether regional disparities are natural or inevitable is discussed (in Poland Lobatch 2004; Tvrdoň, Skokan 2011; Bachtler, Gorzelak 2007) as is whether some regional disparities (e.g. low level of wages attracting investors – Martin, Sunley 1998; Barjak 2001 in Poland) can or cannot be an advantage for some regions in future.

In line with the above-mentioned literature and findings, we assume territorial socio-economic differentiation of Polish subregions according to some territorial gradients and other patterns, especially along the gradients from the peripheral rural subregions to the core urban subregions, along the east-west directional gradient and on the basis of vicinity differently developed foreign regions along the border of Poland (input assumptions).

3. Methodology

To a certain extent, the Polish voivodships ('województwa'; now 16; NUTS 2 level) can be considered as a 'big or medium-sized city and its extensive catchment area'. There are various statistical data available for voivodships published by Eurostat and the Polish Central Statistical Office (GUS). For the purposes of this article, however, voivodships are not well usable because they do not allow the study of differences between rural-urban gradients and cannot be used for state-border regions. Polish *subregions* ('podregiony') are statistical regions of NUTS 3 level (Fig. 1, there were 66 subregions in the reporting period), which were created by one, but mostly several, NUTS 4 districts ('powiats'). They are not self-government regions and mostly not nodal-catchment regions either, but only statistical regions that can be used in regional analyses. However, Churski (2005) mentions a certain role of these subregions in planning for the development of industry, rural areas, urban areas or fisheries-dependent areas. Czyż (2002) favoured subregions in Poland's regional analyses because of their greater diversity. Some studies have worked with even more detailed units – with Polish districts (for example Dolata, Borowczak 2014).

There are studies on the socio-economic differentiation of regions within the superior area based on one key indicator, often GDP per capita. There are also more structured approaches using multiple indicators, sometimes organized into groups. Barjak (2001), Zientara (2008), Chidlow et al. (2009), Churski, Borowczak (2013) or Śleszyński et al. (2017) worked with partial indicators for regions of Poland. For this article, eight *partial indicators* of socio-economic development of subregions (Table 1) that are contextual, relevant, representative in their construction and cover economic, social and infrastructure issues have been selected. Their source data had to be available at the level of subregions for 2002 and 2014. It was obtained from the Central Statistical Office of Poland (GUS 2015).

The indicators for the years 2002 and 2014 were evaluated on the basis of mutual correlations using SPSS software prior to their own analysis. Strong correlations were between newly built flats and net migration rate and also between share of university-educated population and road network density in both years. Growing correlation is between the average monthly wage and share of the university-educated population. There is a growing territorial link

Tab. 1 Partial indicators of socio-economic development in subregions.

Economic indicators (3 indicators): – average monthly wage (in złoty) – employment rate (in %, as a complement to unemployment rate) – newly built flats per 1,000 inhabitants (indication of financial capabilities, activity and satisfaction of inhabitants)
Socio–demographic indicators (3): – share of the economically active population (in %, complement to economically inactive population with pensions and benefits) – net migration rate per 1,000 inhabitants (indication of large or small attraction of the subregion) – share of university-educated population (indication of education level)
Infrastructure indicators (2): – share of population connected to public water – road network density (highways and state roads per km^2)

Source: Own indicators.

between the higher density of road network and the economic and social status of the population.

The values of partial socio-economic indicator for subregions were converted into relative values relative to the median (median = 100). The values of *composite indicator* for subregions were formed as the arithmetic means of these relative values. The use of partial indicator weights was also tested in composite indicator calculations. Other standardization (e.g. z-score) has been considered. However, such procedures did not bring improvements.

The relative values relative to the median do not allow monitoring of changes between 2002 and 2014. To evaluate these changes, it was necessary to return to the original values of the partial indicators and calculate the average growth indicator values between 2002 and 2014 (there has always been growth). Thus, the *average base index* of socio-economic development in the subregions was established (2002 = 100, base indexes of partial indicators, their subsequent arithmetic mean). In Table 2, the composite indicator 2002 values are divided into three ranges – high, medium and small, and average base index values into three intervals – high, medium and small growth. These indicators and indexes have been used to address the first research issue.

In this article big cities have 400,000 inhabitants or more – Warsaw, Kraków, Trójmiasto (Gdańsk + Gdynia + Sopot), Łódź, Wrocław, Poznań and Szczecin. These cities have their *urban subregion* and are surrounded by their *suburban subregion* (suburbanization is strong in the hinterlands of these cities – Gołata, Kuropka 2016), while Warsaw has two such subregions – Fig. 1. At a greater distance from the big cities are *rural subregions*, in this article defined as subregions without cities with 100,000 or more inhabitants. Subregions with a medium-sized city, with 100,000 to 399,999 inhabitants, are referred as *urban/rural subregions* in this article. However, the typology of subregions along the rural-urban concentric gradient is characterized by some problems. In some rural subregions there are cities with 80,000–99,999 inhabitants. Such cities are important second-tier centers in the Czech Republic and Slovakia. Urban/rural subregions sometimes contain relatively large cities (such as Bydgoszcz or Lublin with more than 300,000 inhabitants), which, moreover, often act on neighbouring rural subregions. A certain complication is also represented by the inclusion of subregions lying in Konurbacja górnośląska into the above-mentioned types. Although they have been allocated an urban/rural type, they have a special character. Table 3 shows the values of composite indicators and the average base index in rural, urban/rural, suburban and urban types of subregions.

The directional east-west gradient of the socio-economic development of Poland (third research question) was often mentioned in the literature (see above), but its identification was only visually map-based. In the third research question, two methods of this gradient evaluation were used. First, a simple division of the Polish subregions into the *western, central* and *eastern zone* of Poland (Fig. 1) was used and the differences in the level of development of these zones were identified – Table 2. Only the rural and urban/rural subregions were included in analyses, because distribution of suburban and urban subregions is uneven and the evaluation would be distorted. In the second method, the upper third of the more developed subregions and the lower third of the less developed subregions (according to the values of the composite indicator) were assigned x and y rectangular coordinates (in midpoints of subregions). Subsequently, the *geographic centers* of these two thirds of the subregions were calculated as the sum of multiples of values of the coordinates and the composite indicator values divided by the sum of the composite indicator values. The direction of the directional gradient was determined by linking of the calculated geographic centers.

To solve the fourth research question, the Polish subregions lying at the state border were divided into several *zones of state-border subregions* adjacent to each neighbouring country and to the Baltic Sea – Fig. 1 and Table 4. Some state-border subregions

were adjacent to two countries and were therefore included in two zones. The length of the border and the presence of border crossings have not been taken into account in this procedure.

4. Territorial differentiation of socio-economic development of Polish subregions 2002–2014

Differentiation of Polish subregions in 2002 and 2014 by composite indicator values is shown in Fig. 2 and 3. The maps represent the state before Poland's accession to the EU in 2004 and the state after ten years of Poland's inclusion in the EU. Differences between observed years are not too large in the maps. Urban subregions of Kraków, Wrocław, Warsaw and Trójmiasto had the highest values in 2014. In the second group of subregions there were urban subregions of the remaining big cities, five suburban subregions (Poznański, Warszawski-zachodni, Wrocławski, Gdański and Łódzki) and the Katowicki and Bydgosko-toruński subregion (two large cities). In the third group with somewhat lower values, there were other suburban subregions

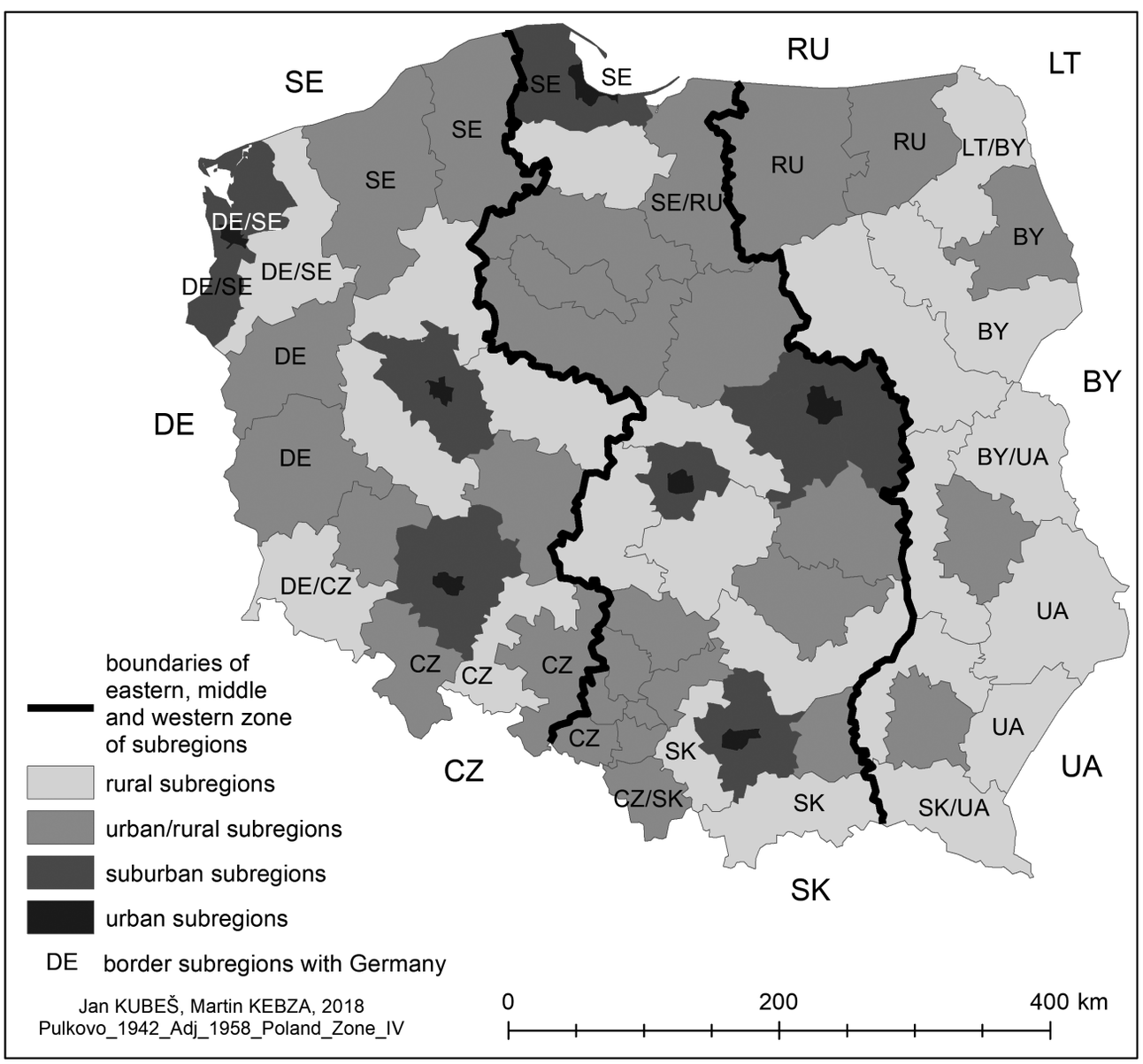

Fig. 1 Types of Polish subregions along rural-urban concentric gradients, subregions in eastern, central and western zone of Poland and state-border subregions in the zones along the state border.
Note: Further explanation in the text.
Source: Own classification of subregions.

around the big cities, two subregions of the Konurbacja górnośląska (Gliwicki, Tyski and Sosnowiecki) and at the very end also some subregions with medium-sized cities (Lubelski, Białostocki, Rzeszowski). On the other hand, low values of composite indicator appeared in eastern Poland, in rural subregions of Podlaskie, Lubelskie and Podkarpackie voivodships, also in the mid-northern and south-west part of Poland and individually elsewhere. The composite indicator includes 8 partial indicators and the values of these partial indicators are more diverse – see Kubeš, Kebza (2016).

Different *acceleration of growth of individual Polish subregions* between 2002 and 2014 can be seen in Fig. 4 through the average base index and growth types of subregions. The area in the Lower Silesia, along the river Oder, including the Polish-Czech borderland, roughly from Rybnicki to the Legnicko-głogowski subregion with its core in Wrocław, is developing rapidly (it benefits from the proximity of Germany and Czechia). A similar area including the north-western, south-western and central part of Łódzkie voivodship (it newly benefits from a central position at the intersection of Polish important road and rail communications) is linked to previous area. High growth was also recorded in the Gdański suburban subregion. On the other hand, small growth took place in the belt west and south of Warsaw (probably a strong concentric influence of this city), with a continuation to the subregion Grudziądzki (this peripheral area is far from big cities – Śleszyński, Komornicki 2016; Śleszyński 2016) and also in the mid-southern

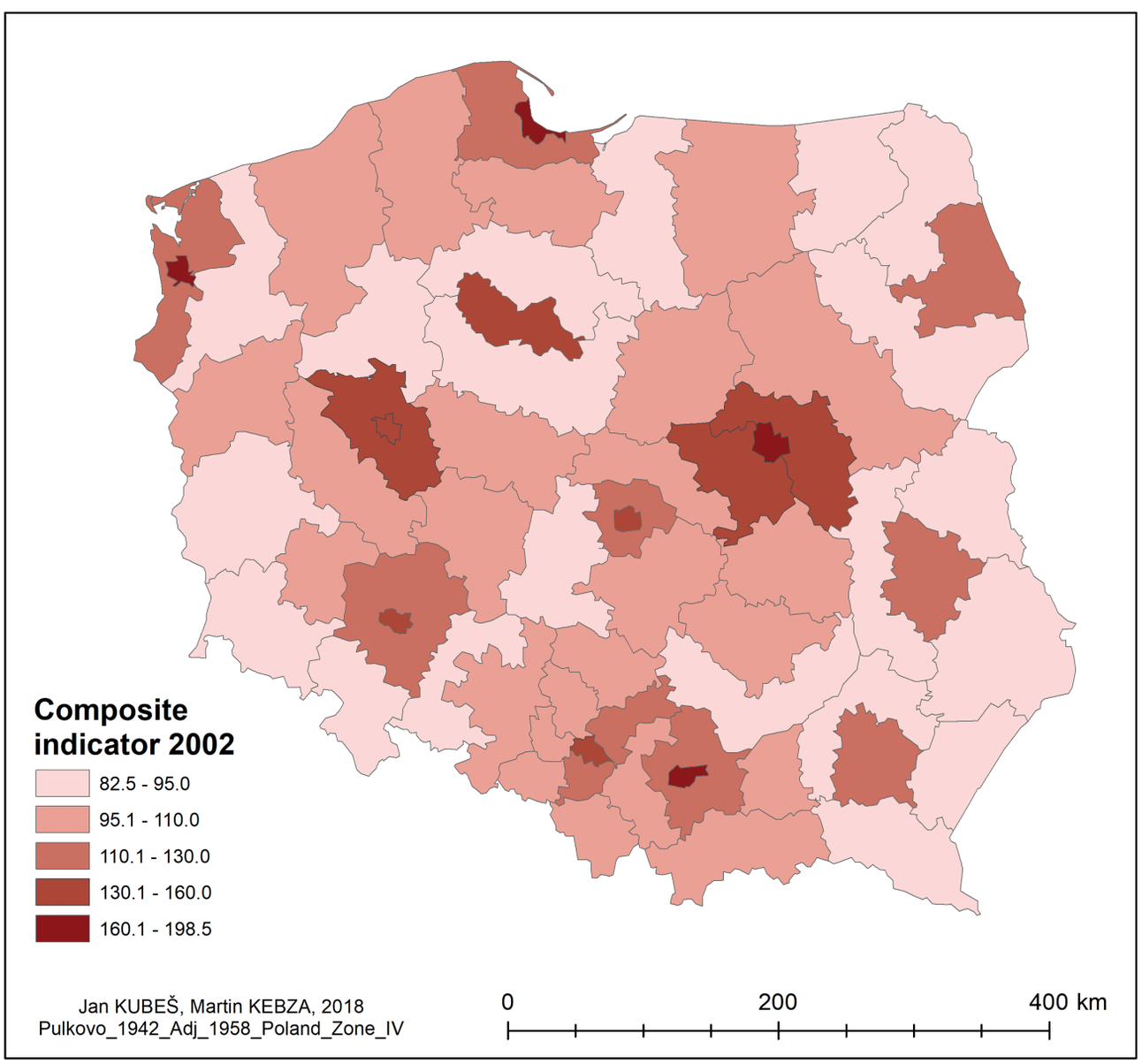

Fig. 2 Polish subregions according to the values of composite indicator in 2002.
Source: Own calculations based on the data from GUS (2015), explanation in the text.

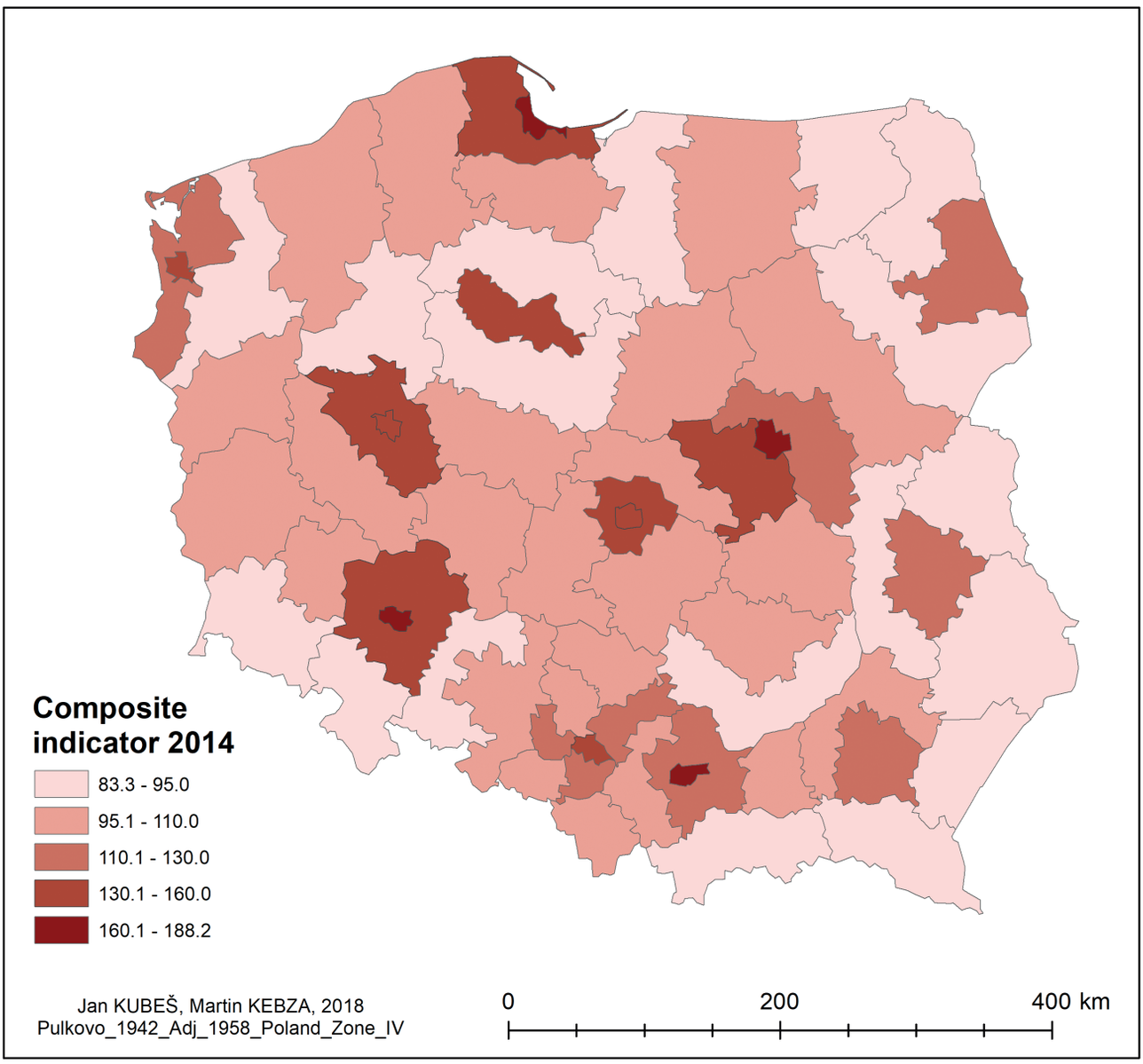

Fig. 3 Polish subregions according to the values of composite indicator in 2014.
Source: Own calculations based on the data from GUS (2015), explanation in the text.

and south-eastern part of Poland – wider near Kraków (with the decline of the local mining and metallurgical industry) and mountain subregions along the Slovakian border (Fig. 4).

The smallest growth in the group of subregions with high development in 2002 (HS in Fig. 4) was reported by the city of Warsaw (however, the value of the composite indicator is still high here) and Szczecin, also the Warszawski-zachodni suburban subregion (still high values) and surprisingly also Krakowski or Poznański suburban subregions. The Sosnowiecki subregion in the Konurbacja górnośląska was similar. The smallest growth in the group of subregions with medium development in 2002 (MS) was found in the inner periphery of Poland between Warsaw, Łódź and Kraków, along the border with Slovakia and surprisingly in the Gorzowski subregion at the border with Germany (here the growth has been already in the 1990s). Seven subregions with poor initial conditions in 2002 had a small growth until 2014 (SS) – Fig. 4. They are located at the eastern border of Poland, at the border with the Kaliningrad region of Russia and one was at the border with Germany (the Zielonogórski subregion; also here the growth appeared already in the 1990s as well).

On the other hand, the city of Łódź, Kraków and Katowice, the Łódzki, Gdański and Wrocławski suburban subregions, and in addition Rzeszowski and Lubelski subregions (with growing cities in the east of Poland) recorded the highest growth among subregions with high development in 2002 (HH). The highest growth among medium developed subregions in 2002 (MH) was reported, for example, by the Gliwicki and Bielski subregions in the Konurbacja górnośląska

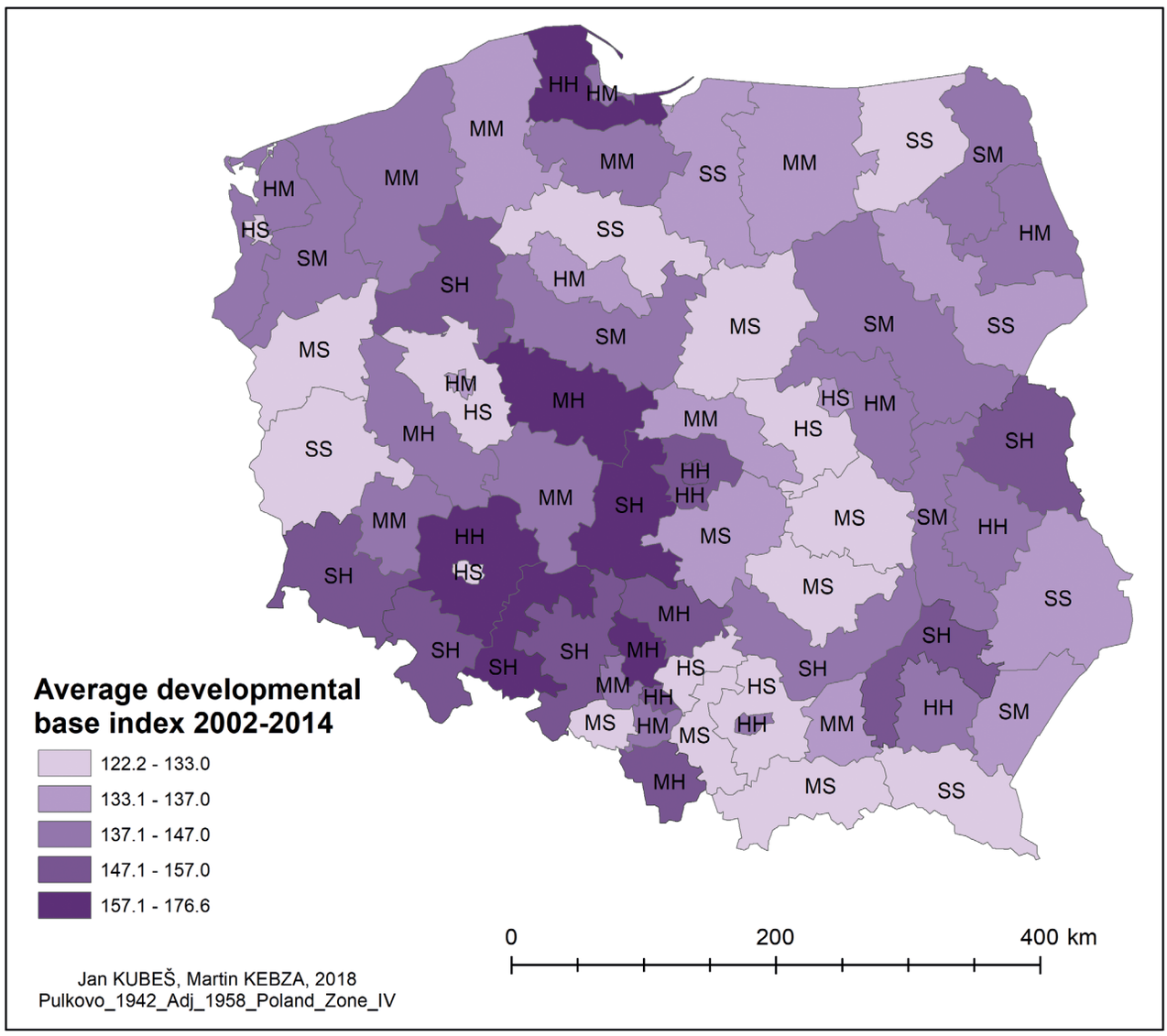

Fig. 4 Polish subregions according to the values of average base index 2002–2014.
Note: Letter codes are explained in Table 2.
Source: Own calculations based on the data from GUS (2015), explanation in the text.

(development of the automotive industry) and in the group with small development in 2002 (SH), for example, by the Jeleniogórski, Wałbrzyski, Nyski and Opolski subregions (along the border with Czechia and in the above-mentioned development area of Lower Silesia).

Lobatch (2004) referred to the lagging Polish regions as either 'laggers' (from the beginning lagging behind and unable to overcome their lagging behind) or as 'losers' (they lost their formerly good position, e.g. regions with declining industry). In Fig. 4 and Table 2, such subregions could be designated SS or HS (+MS).

Nevima, Melecký (2011), Czyż, Hauke (2011) or Churski, Borowczak (2013) recorded weaker convergence trends according to the Polish voivodships. On the other hand, Petrakos (2001), Czyż (2002), Churski (2005), Stryjakiewicz (2009), Tvrdoň, Skokan (2011) and Zdražil, Kraftová (2012) found growing differences between Polish voivodships. However, convergent and divergent tendencies were not significant; the outcome depended on the indicators used, the regional level, the monitoring period and the measurement method. The sum of the deviations from the median in the composite indicator for 2002 (for subregions) was 7240 and in 2014 it was 7353. This could indicate weaker divergence trends for 2002–2014 on the NUTS 3 level. On the other hand, in Table 2 it can be seen that subregions, which had bad initial conditions in 2002, had in more cases high growth. Good standing subregions of big Polish cities in 2002 tended to have little growth. This would indicate convergence trends. However, this indication would have to be verified by a more demanding econometric analysis.

Tab. 2 Growth types of Polish subregions 2002–2014.

Type of subregions	Composite indicator 2002	Composite indicator 2014	Average base index 2002–2014
H. Subregions with high development in 2002 (22 subregions)	138.7	138.7	140.9
HH. Subregions with high development + high growth (8)	134.8	138.4	153.1
HM. Subregions with high development + medium growth (7)	135.2	132.1	137.8
HS. Subregions with high development + small growth (7)	139.2	140.3	129.0
M. Subregions with medium development in 2002 (22)	101.8	103.0	138.6
MH. Subregions with medium development + high growth (5)	103.4	105.0	156.0
MM. Subregions with medium development + medium growth (9)	100.4	103.1	138.6
MS. Subregions with medium development + small growth (8)	102.5	101.6	127.8
S. Subregions with small development in 2002 (22)	88.5	92.6	142.8
SH. Subregions with small development + high growth (9)	89.4	94.3	153.3
SM. Subregions with small development + medium growth (6)	89.7	92.2	139.8
SS. Subregions with small development + small growth (7)	86.3	90.6	132.0

Note: Subregions types are explained in the text.
Source: Own typology and calculations based on the data from GUS (2015).

5. Geographic patterns in the socio-economic development of Polish subregions 2002–2014

The second research question is focused on the differences in the socio-economic development of the *Polish subregions along the rural-urban concentric gradients* between 2002 and 2014. From the mosaic of Polish subregions according to the composite indicator in 2002 (Fig. 2) and 2014 (Fig. 3), the big cities (urban subregions) and their suburban subregions stand out. In Table 3, the composite indicator values are grouped into rural, urban/rural, suburban and urban types of subregions to confirm the existence of rural-urban concentric gradients in Poland. Urban subregions have the highest values in both years, but in the period under review there is a relatively small increase in the average base index (especially in Warsaw and its suburban subregions). Other suburban subregions grew considerably between 2002 and 2014. Some urban/rural subregions have significant growth, especially two east subregions – Lubelski and Rzeszowski – with relatively large cities – Lublin and Rzeszów (these cities are getting closer to other similar cities in Poland) and some subregions in the Konurbacja górnośląska (they recorded little development in the 1990s). Rural subregions are the last ones in terms of values in both years, but some of them have significant growth (Table 3).

Also Ferry (2004) writes about the existence of disparities along the Polish rural-urban gradients. Churski (2005) observed developmental differences between individual cities and their peripheral catchment areas. The smallest differences have been discovered in the region of Lublin. Czyż (2002) casts some doubt on the existence of such gradients around Polish cities. According to her, only the wider regions of Warsaw, Poznań and Wrocław have a well-organized structure and 'core-periphery' interactions.

The third research question aims to confirm or rebut the hypothesis about the existence of a *directional east-west gradient* of the socio-economic development of the Polish subregions in 2002 and 2014. In Fig. 1 Polish subregions are included in the western, central and eastern zone of Poland.

Differences of composite indicator values and average base index values for these zones in the period 2002–2014 can be found in Table 3 (only rural and urban/rural subregions are included in the zones). According to this table, the east-west gradient is evident in rural subregions both in 2002 and 2014 (D3 × D1). Higher values in D2 can be attributed to the fact that in the middle zone there are 4 of the 7 Polish big cities (including Warsaw) positively influencing the surrounding rural subregions. In the case of urban/rural subregions, the opposite – west-east gradient can be found. It is caused because in eastern C3 there are urban/rural subregions with 'three hundred thousand' cities (Lublin, Rzeszów and Białystok). Such big cities are not in the western C1 zone. In the middle C2 zone, the very specific subregions lie in Konurbacja górnośląska.

The second method of determining the directional gradient of the socio-economic development of the Polish subregions is based on the interconnection of geographical centers of the upper and lower thirds of subregions according to the values of the composite indicator, both in 2002 and 2014. Such conceived gradient was set – for the year 2002 – in a line passing near the city of Łódź. It was heading east-west with a slight deviation to the north (azimuth approximately 280°). In 2014, this gradient was already heading east-west. This east-west gradient of Poland was visually identified by a number of authors – Surazska et al. (1997), Lobatch (2004), Churski (2005), Stryjakiewicz (2009), Churski, Borowczak (2013) and others.

The fourth research question is focused on understanding the differences in the socio-economic

Tab. 3 Socio-economic development of Polish urban, suburban, urban/rural and rural subregions, 2002/2014.

Type of subregions	Comprosite indicator 2002	Composite indicator 2014	Average base index 2002–2014
A. urban subregions big cities (400,000+ inhabitants; 7 subregions)	166.6	164.4	137.7
A1. urban subregions of Warsaw (1)	192.3	178.1	135.8
A2. urban subregions other big cities (6)	162.3	162.1	138.0
B. suburban subregions big cities (8)	128.1	130.3	144.4
B1. suburban subregions of Warsaw (2)	141.7	134.8	134.5
B2. suburban subregions other big cities (6)	123.6	128.8	147.7
C. urban/rural subregions (cities with 100,000–399,999 inhab.; 29)	104.0	106.4	138.7
C1. urban/rural subregions in western zone of Poland (8)	96.6	101.2	139.1
C2. urban/rural subregions in middle zone of Poland (16)	107.3	108.1	138.4
C3. urban/rural subregions in eastern zone of Poland (5)	105.6	109.4	138.9
D. rural subregions (22)	92.4	94.3	143.2
D1. rural subregions in western zone of Poland (6)	92.8	96.2	152.2
D2. rural subregions in middle zone of Poland (7)	98.5	97.6	139.5
D3. rural subregions in eastern zone of Poland (9)	87.4	90.4	140.0

Source: Own typology and calculations based on the data from GUS (2015).

development of the *state-border subregions in zones along the border of Poland* with individual neighbouring countries and the Baltic Sea in 2002 and 2014. Subregions by the Baltic Sea had the highest values of composite indicator and the second highest growth between these years – Table 4. High values also result from the fact that there are two big cities/agglomerations (Szczecin and Trójmiasto) and their suburban subregions. Next, there are state-border subregions along the border with Germany (including also Szczecin and its suburban subregion; the lowest growth, which can be explained by high growth in the 1990s) and following are subregions along the border with Czechia (highest growth). Worse values of the composite indicator (2014) were found in subregions bordering with Slovakia (4th order), Belarus (5–6), Russia (5–6), Lithuania (7), and the subregions on the border with Ukraine (8) – Table 4.

Seacoasts in the Trójmiasto and Szczecin subregions have a good position and development due to, inter alia, the international maritime transport of goods (see also Gorzelak 1998 or Chidlow et al. 2009). On the Polish-German and Polish-Czech state borders there are cross-border highways, facilitating beneficial developmental effects. There is also cross-border 'euro-regional' cooperation (Stryjakiewicz 2009; Dołzbłasz 2013). The borders of the Schengen zone in eastern Poland are difficult to penetrate, and regions on the other side of the state border are not doing well economically (similarly Gorzelak 1998). Greater Polish-Slovak cooperation could help the somewhat slowly developing Polish subregions along the Slovakian border. We cannot explain the relatively good position of subregions on the border with Russia in Table 4 (this is the Kaliningrad region of Russia).

In addition to the above-mentioned geographic models of socio-economic development, various *local factors* influence the development of individual Polish subregions. Newly formed universities in the medium-sized cities in eastern Poland (in Olsztyn, Białystok, Lublin and Rzeszów) certainly favourably affect the development of these subregions and their surroundings. Only in recent years has Poland succeeded in creating a network of highways. The main highway intersections are located in central and mid-southern Poland – near Łódź (the city and its southwestern background grew significantly in the period under review – Fig. 4) and Katowice (also grow). New highways also help to develop rural

Tab. 4 Socio-economic development in the zones of state-border subregions of Poland, 2002/2014.

Zones of state-border subregions along the border with	Composite indicator 2002	Composite indicator 2014	Average base index 2002–2014
DE. Germany (6 subregions)	109.2	107.7	134.1
CZ. Czechia (6)	94.0	99.3	148.9
SK. Slovakia (4)	99.6	95.9	134.6
UA. Ukraine (4)	85.5	87.4	138.1
BY. Belarus (4)	93.9	95.6	140.3
LT. Lithuania (1)	88.8	89.5	141.4
RU. Russia (3)	91.1	95.6	134.4
SE. Baltic Sea (8)	120.2	117.1	141.6

Source: Based on the data from GUS (2015).

and suburban subregions, because they are being brought closer to big and medium-sized cities. There are good conditions for development in subregions with developed large industrial enterprises – Ciechanowsko-płocki (big oil refinery PKN Orlen), Tyski and Gliwicki (automotive industry), Bielski (development of new technologies) and Rzeszowski (aerospace industry) subregions.

However, there are also factors that adversely affect the development of some Polish subregions. Subregions along the border with Slovakia (Nowosądecki, Krośnieński) have a mountain and foothill character and subregions of Pomeranian and Masurian Lakeland have numerous lakes, wetlands and related waterlogged soils. These natural conditions have a negative impact on local transport, agriculture and settlement (Ferry 2004). In the Śląskie and Małopolskie voivodships, Poland's black coal and metallurgical industries are facing economic problems (particularly in the Rybnicki, Sosnowiecki a Oświęcimski subregions) and still pollutes the atmosphere (see Leśniok 2011). The result is a high unemployment rate and the withdrawal of the population.

7. Conclusions

The economic and social growth of the Polish subregions was considerable between 2002 and 2014, as evidenced by the values of the analysed partial indicators; in particular the average monthly wages, the newly-built flats per thousand inhabitants and the shares of the university-educated population (details in Kubeš, Kebza 2016). In terms of composite indicator values in 2014, the best position was held by the urban subregions of Kraków, Wrocław, Warsaw and Trójmiasto. The largest growth between 2002 and 2014 in the case of big cities was experienced by Łódź (decrease due to the transformation has ended, a favourable geographical position within Poland) and Kraków, the smallest by Sczeczin (peripheral position within Poland). The suburban subregions surrounding big cities had relatively high values and average growth. Subregions with large cities in the east of Poland were characterized by high growth (it is favourable for Polish regional development). The area along the central Oder River in Lower Silesia with its core in Wrocław, including the belt to the city of Łódź, was the fastest developing in the period under review – Fig. 4. Low values of the composite indicator in 2014 were reported by rural subregions of south-eastern and partly north-eastern Poland and rural subregions in the inner periphery of the mid-northern part of Poland – Fig. 3.

The existence of the socio-economic rural-urban concentric gradients (second research question) has been largely confirmed by the method used (Table 3), but significant medium-sized cities in the urban/rural subregions are somewhat disruptive to the procedure. The socio-economic underdevelopment of subregions in eastern Poland and the existence of the east-west gradient of development of the Polish subregions (third research question) was also confirmed by the methods used (Table 3 and calculations of geographical centers). Subregions lying on the shores of the Baltic Sea and on the border with Germany and Czechia were socio-economically better than the subregions on the borders with Belarus, Slovakia, Russia and especially on the border with Lithuania and Ukraine (Table 4, fourth research question).

Polish subregions of NUTS 3 level, as compared to the Polish voivodships (NUTS 2), proved to be relatively appropriate territorial units for monitoring territorial socio-economic differentiation inside Poland. Rural-urban concentric gradients would certainly be more accurately investigated using smaller territorial units, but statistical data is not available for such units. This also applies to the analysis of the border territories of Poland. There is not enough space in the article to present the values of individual partial indicators (see Kubeš, Kebza 2016). The composite indicator's use of these values tends to be flatter, but is more appropriate than one-dimensional procedures based solely on GDP or wages. Certainly, more sophisticated methods could be used to standardize the values of partial indicators.

Polish regional policy will probably always have to deal with the question of whether to primarily support lagging and handicapped regions in order to alleviate their socio-economic lag or whether to primarily stimulate economic structural changes, increase competitiveness and innovation in all regions, or whether a mix of these policies will be the most appropriate (similar to Lobatch 2004). Urban and suburban subregions will always be at the forefront of the level of socio-economic development. On the other hand, some parts of Poland, such as the East, inner peripheries and countryside, cannot be left without help as well as Polish eastern borderlands or the structurally affected and contaminated subregions in the Śląskie voivodship. In Poland, variants of a new regional policy have been discussed for some time (see, for example, Bachtler, Gorzelak 2007; Churski 2010; Churski, Borowczak 2013; Churski 2014 or Nowak 2015). One of the proposals is the abandonment of the compensatory regional policy in Poland and the preference of a polarization-diffusion policy that includes, inter alia, the formation of functional transport links between the growth and stagnation areas within the voivodships, with the aim of concentrating economic support on development of a smaller number of developmental localities. However, traveling to work and services from lagging areas to relatively distant developmental localities presents considerable discomfort and stigmatization for the inhabitants of lagging areas. A favourable diffuse impact on these areas is not guaranteed. The new Strategy for Development of Poland (URM 2017) is not so strict, nevertheless

it supports the comprehensive development of public transport inside voivodships and the construction of modern roads and railways within Poland.

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