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## SPATIAL CLASSIFICATION OF RURAL AREAS IN POLAND

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### Abstract

Today, the functions of rural areas are changing; having been mainly agricultural and forested they are increasingly becoming touristic and residential, especially those that are situated in suburban and coastal regions. Spatial typologies are commonly developed on population density which we found could be substituted by land use. The elaboration demonstrates the procedure which led us to a spatial classification of all the local administrative units in Poland (*gmina* – NUTS5). As a result 7 classes were distinguished. The goal is to create a standard of division based on universal, readable and easily interpretable indicators which will make the results more intelligible.

### Key words

rural areas • spatial classification • spatial typology • land use • Poland

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### Introduction

There are two main causes that have led the Central Statistical Office of Poland (GUS) to make an effort to create a new form of classification of rural areas. First, rural areas' functions are changing; having once been mainly agricultural and forested, today they are becoming residential in suburban zones, and touristic in coastal, mountainous and lake regions, and transport along highways and around airports. Second, the administrative borders of cities are not showing exactly the boundary between these functional areas.

This issue introduces a new approach to the spatial typologies of rural areas. The division of territories was made on land use indicators. Spatial classification is the first part of a larger work, whose other elements will be presented in the near future. Therefore, this article does not discuss the socio-economic, developmental, environmental and other aspects of rural areas.

The goal of the methodological work is to present a concept of the division of rural areas, and its possible applications based on official statistical data. It also should meet the quality requirements specified in *The European Statistics Code of Practice* (Eurostat 2012). The concept of division originates not only from the

standard of reliability, but also from the principle of relevance. The emergence of a classification is a response to the needs of a wide range of users with varied knowledge and information processing capabilities. The classification should provide a readable and easy to understand image, which satisfies the principle of accessibility and clarity. Meeting these rules requires a degree of generalization, which does not contradict the condition of accuracy. The introduction of a new classification will not change the existing register, so it will be possible to use the division based on the kinds of *National Official Register of the Territorial Division of the Country* (TERYT) units in parallel (GUS 2012).

Today, official statistics in Poland use the TERYT register, in which state territory is divided into city and non-city units. The administrative criterion regulated by the Council of Ministries is the only basis for this distinction. Cities in Poland are individual communes (*gminas*) – second level of local administrative units (LAU2), or parts of urban-rural *gminas*. This division does not allow one to make broader characterisations of rural areas and their internal variety.

## Literature review

Many different typologies of rural areas have been presented (Copus et al. 2008). We will distinguish between three different types – spatial, socio-economic and combinative (Bański 2009). Spatial typologies show population distribution and accessibility to cities. They mainly use population density (OECD 2010; Eurostat 2010) and the time of a journey to a city with a defined minimum number of inhabitants (Dijkstra & Poelman 2008) as indicators. Spatial typologies divide rural areas into densely and sparsely populated, or accessible and remote, but do not show the socio-economic structures of rural areas. Socio-economic typologies feature the main existing economic functions in analyzed spatial units. These divisions use territorial (the share of agricultural areas, forest cover), social (the share of persons with a high education, the share of registered unemployed persons), economic (the number of entities per 1,000 inhabitants, GDP per capita, the share of commuters), touristic (the number of beds in accommodation establishments per 1,000 inhabitants) and other indicators. The advantage of these divisions is that they show the spatial variation of a rural economy and social issues. On the other hand, these typologies often use dozens of indicators, including those that are qualitative, aggregated in different ways. Socio-economic typologies are rarely transparent. Another problem is the availability of data. There is always the possibility that some indicators will cease to be measured (Bański & Stola 2002). Combinative typologies use indicators which are typical both for spatial and socio-economic divisions. They are the most complicated and have the same disadvantages as socio-economic typologies.

The most well-known typology is that of the OECD (OECD 2010). In Europe the Eurostat urban-rural typology (Eurostat 2010) is also in use. Both typologies are spatial and based on a population density indicator, but they use a different limit between urban and rural areas – 150 inhabitants per km<sup>2</sup> in the OECD typology, and 300 inhabitants per km<sup>2</sup> in the Eurostat typology. Furthermore, the OECD typology is based on LAU2 units and the Eurostat typology uses 1 km<sup>2</sup> grid cells. Both typologies create a distortion when a relatively big city is surrounded by a rural region. They classify the region as urban or intermediate, when the land is in fact predominantly used for agriculture and forestry. The use of the population density indicator leads to another problem in Poland. Some rural areas in Śląskie, Małopolskie and Podkarpackie voivodships are so densely populated that they are considered as being intermediate in both typologies mentioned above.

Scientists have created many typologies of rural areas at local or regional levels (Copus et al. 2008). Several typologies for Polish gminas have been developed (LAU2 units) (Stola 1993; Rosner 2002; Bański & Stola 2002; Jonard et al. 2007; Komornicki & Śleszyński 2008; Bański 2009), which are relatively big units in comparison to the European average (Gallego 2010). A gmina's average area is 126 km<sup>2</sup> and it has an average population of 15.4 thousand inhabit-

ants. Moreover, along with urban and rural gminas, there exist 602 urban-rural gminas, where one administrative unit consists of a town and surrounding villages. This dichotomy ensures that any analysis is not sufficiently precise. The Central Statistical Office of Poland has some data about urban-rural gminas divided into two parts – urban and rural. This paper is based on units obtained after the partition of urban-rural gminas, which can be called LAU2+ units. Poland is composed of 3,081 LAU2+ units, of which 908 are cities and towns, and 2173 are rural. Their average area is 101.5 km<sup>2</sup> and the average population is 12,400 inhabitants.

## Methodology

Spatial typologies are commonly based on population density. However, Kostrowicki (1976) proposed a division based on the results of land use analysis. The relationship between these factors has been examined. The ESPON Report 1.1.2 (Bengs & Schmidt-Thomé 2005) produces a graph where population density was correlated with the share of artificial areas at NUTS3 level for EU countries. Artificial areas were taken from Corine Land Cover images. The linear Pearson correlation between the indicators was 0.85.

We produced a very similar correlation for LAU2+ units in Poland based on population density data from the Local Data Bank (*Bank Danych Lokalnych – BDL*) and land use data from the Land and Building Registry (*Ewidencja Gruntów i Budynków – EGiB*) for 2010. We assumed that small local units would be more homogenous than regions, so the correlation ought to be higher. We substituted the share of artificial land for the share of built-up and urbanized areas determined by the Head Office of Geodesy and Cartography (*Główny Urząd Geodezji i Kartografii GUGiK*). This administrative data are based on the legal status of plots. Built-up and urbanized areas included residential, industrial, urbanized unbuild, recreational, transport, mining and other built-up areas. The administrative data are more detailed than satellite images, where the minimum area of a unit is 0.25 km<sup>2</sup>. Satellite images reduce the share of built-up and urbanized areas, because nearly all roads are too narrow and too small to be determined. The Corine Land Cover 2006 project determine 3.99% share of artificial land of the total land area in Poland (Ciołkosz 2008) in comparison with a 4.77% share of built-up and urbanized areas.

With both variables, population density and the share of built-up plus urbanized areas, have the same advantages. Any human activity needs executors and space. Agricultural and forestry activities require a vast area but relatively few people. On the other hand, industry, transport and services need many people but little space. Some places exist where human activity is sporadic or absent, so the shares of the areas should be counted not as a percentage of the total area, but rather as a percentage of total used area. Consequently, we have subtracted from the total area the land which could not be economically used,

like lakes, rivers, sea, wastelands and those classified as 'other'. The whole used area could be a triset for agricultural, forested and built-up plus urbanized areas. This division allows one to show every unit on a trilinear-diagram.

The effect of our correlation is shown in Figure 1, where the Pearson correlation is 0.94. It means that population density could be substituted by the share of built-up and urbanized areas in the total used area. In some typologies (Bengs & Schmidt-Thomé 2005; Jonard et al. 2007) both population density and a share of artificial area indicators were used. In the case of such a strong correlation, only one of these ought to be used. A share of built-up and urbanized areas is a much better indicator, because it covers the entirety of agricultural and forested areas. It allows for the depiction on one choropleth map cities, agricultural land and forested areas through the use of only one indicator.

A closer look at Figure 1 allows one to see that the correlation is not perfectly linear. Detached houses dominate villages, whereas cities are dominated by blocks of flats, where a lot of people live in a small area. Population density grows faster than the area occupied by intensive land management. The relationship between the indicators can be written as follows:

$$LUU = \frac{p^{\frac{3}{4}}}{600} \quad (1)$$

where:

- LUU* – the share of built-up and urbanized areas in the total used area,
- p* – population density.

Equation (1) means that the OECD urban/rural border 150 inhabitants per km<sup>2</sup> corresponds with 7.14% *LUU*. Typologies have been created where the border between urban and rural areas was based on the share of artificial area. The ESPON 1.1.2 typology (Bengs & Schmidt-Thomé 2005) defines high human intervention as a 3.48% share of artificial area which could be correlated with 4.18% *LUU* and 73.4 inhabitants per km<sup>2</sup>. On the other hand Jonard et al. (2007) use a threshold of a 10% share of artificial area, which could be correlated with 12% *LUU* and 299.5 inhabitants per km<sup>2</sup>.

### Input data analysis

The discrepancies between the typologies are so significant that it raises the question as to whether a clearly visible border actually exists between rural and urban areas in the share of built-up and urbanized areas. We have analyzed the situation in all 16 voivodships (regional administrative units) in Poland and have noticed that in almost 90% of rural units the *LUU* is less than 6%, which corresponds with a population density of 120 inhabitants per km<sup>2</sup>. It means that agricultural and forest land is mostly visible in their landscapes. The rest (10%) of rural *LAU2+* units, where the *LUU* is higher than 6%, are situated in some specific places. First of all, most of them are situated in suburban areas. Sometimes these units perform the functional role of an urban area, which is best seen in Raszyn near Warsaw. Secondly, they include rural units where sizeable open pit mines are located. Thirdly, they include the coastal zone where tourist infrastructure is localized. Fourthly, they include those areas in the vicinity of airports or highways. On the other hand, in urban

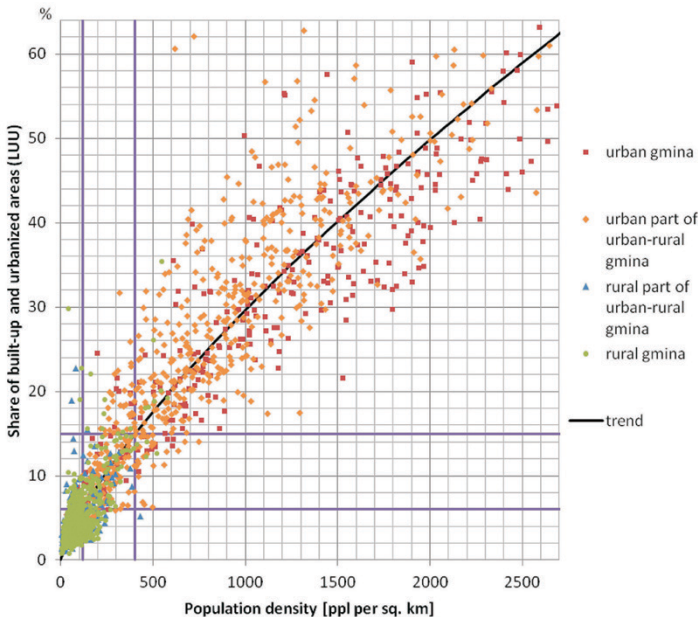


Figure 1. Correlation between population density and *LUU* for *LAU2+* units in Poland.

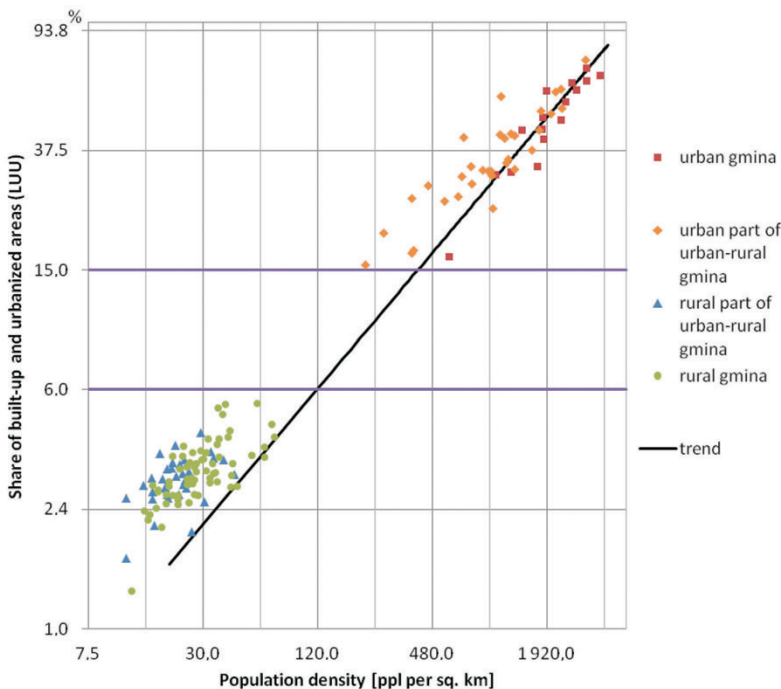
LAU2+ units the *LUU* is lower than 15%, which corresponds with a population density of 400 inhabitants per km<sup>2</sup>, only if there are vast surrounding agricultural or forest areas incorporated into the cities' boundaries. This practice was popular between 1945 and 1990.

Both spatial changes, the urbanization of rural areas and the incorporation of rural areas into the cities' boundaries, took place with different levels of intensity in most of the regions in Poland. For instance, the suburbanization process appears most intensively around the Warsaw, Poznań, Wrocław and Gdańsk agglomerations. Neither of these changes took place intensively in the Warmińsko-Mazurskie voivodship due to the lack of big cities, highways, vast mineral deposits etc. The modern history of the urbanization of this region is very interesting. According to the 1931 (GUS 1938) and 1933 (Statistisches Reichsamt 1938) census data before the Second World War, around 1.2 million inhabitants were living there, mostly in rural areas. The region was significantly depopulated just after the war as a result of the emigration of the German population. In the last 60 years the cities in the Warmińsko-Mazurskie voivodship have been growing; in contrast, in the same period rural areas have been depopulating. Today 1.427 million inhabitants live in this region, most of them dwelling in the cities. The spatial organization resembles the traditional division into cities and rural areas. An effect of this small change is that all rural areas in Warmińsko-Mazurskie voivodship have an *LUU* of less than 6%, and all the cities have an *LUU* of more than 15% (Fig. 2).

## Concept of division

Based on the literature and the input data, an analysis of the concept of division was developed on the LAU2+ scale. The classification includes all territorial units, because of the blurring of the dichotomy between cities and rural areas. It is based on simple and understandable indicators. All the indicators belong to a group that have been generally accepted, or correlate with one of them. Our concept is based on land use structure indicators and population variable. The advantage of these data is the ability to carry out changes with annual frequency. The spatial classification of rural areas in Poland distinguishes 7 classes:

- a) urbanized  
 $\{LUU/(LUA+LUF+LUU) > 15\% \} \& \{POP > 5000\}$
- b) forested, partly urbanized  
 $\{LUU/(LUA+LUF+LUU) \in [6\%; 15\%] \} \& \{LUA/LUF < 1\}$
- c) agricultural, partly urbanized  
 $\{LUU/(LUA+LUF+LUU) \in [6\%; 15\%] \} \& \{LUA/LUF \in [1; 4] \}$
- d) predominantly agricultural, partly urbanized  
 $\{LUU/(LUA+LUF+LUU) \in [6\%; 15\%] \} \& \{LUA/LUF > 4\}$
- e) forested  
 $\{LUU/(LUA+LUF+LUU) < 6\% \} \& \{LUA/LUF < 1\}$
- f) agricultural  
 $\{LUU/(LUA+LUF+LUU) < 6\% \} \& \{LUA/LUF \in [1; 4] \}$
- g) predominantly agricultural  
 $\{LUU/(LUA+LUF+LUU) < 6\% \} \& \{LUA/LUF > 4\}$



**Figure 2.** Correlation between population density and *LUU* for LAU2+ units in the Warmińsko-Mazurskie voivodship.

where the various abbreviations mean:

- LUU* - built-up and urbanized areas
- LUA* - agricultural land
- LUF* - forest land
- POP* - population

If a population of a territorial unit is less than 5,000 people, but it meets the other criteria of an urbanized class, then this unit is classified as partly urbanized. Graphical representation of the division is in the form of a trilinear-diagram (Fig. 3), where the vertices are: agricultural land (*LUA*), forest land (*LUF*) and built-up plus urbanized areas (*LUU*).

The advantage of the proposal is the possibility of merging several classes into one. For example, three partly urbanized classes can be combined. This allows us to use the classification at several levels of aggregation. This is particularly important for surveys in which the number of data varies in different studies. The possibility also exists for a further division of classes: for example, to ungroup the urbanized class according to the population of the cities.

**Results**

The results of the classification can be showed on a trilinear-diagram, map and in tables. On the diagram (Fig. 4) it can be seen that the majority of rural areas are under the 6% *LUU* threshold. On the other hand, the majority of the cities are over 15% of the *LUU* demarcation. Both thresholds are depicted on Figure 4

as violet lines. All kinds of administrative units occur between these two violet lines without the domination of any single one of them. There exist a small number of cities under the threshold of 6% *LUU*, and some rural areas that are over the threshold of 15% *LUU*. It can also be seen that forest land usually occurs in cities on a much smaller area than on agricultural land.

The choropleth map (Fig. 5) shows the spatial distribution of classes. It presents a plain image of extensive forest areas (marked as light green) in the Lubuskie voivodship, Carpathian Mountains and Masuria. Moreover, many smaller forests can be easily identified, for example: the Białowieża Forest. Extensive territories that are predominantly agricultural (marked as light orange) coincide with the main food producing areas (Bański 2010). We can easily find them on the Lublin Uplands, Silesian Lowlands, and North Mazovian Lowlands. Furthermore, many food producing areas that are smaller in size can be seen - like Żuławy Wiślane (the Vistula river delta). Agricultural and predominantly agricultural territories dominate in central Poland, while the north and west voivodships are more wooded.

Large urban regions, which contain adjacent urbanized and partly urbanized units, are also clearly visible. The most developed large urban regions are: Warsaw, the Upper-Silesian agglomeration, Poznań, Wrocław and Trójmiasto (the Gdańsk-Sopot-Gdynia agglomeration). Kraków, Łódź, Szczecin, Bydgoszcz, Kielce, Płock are centres of smaller regions. The range of these regions shows how far from the central city the residents are building their homes. On the other

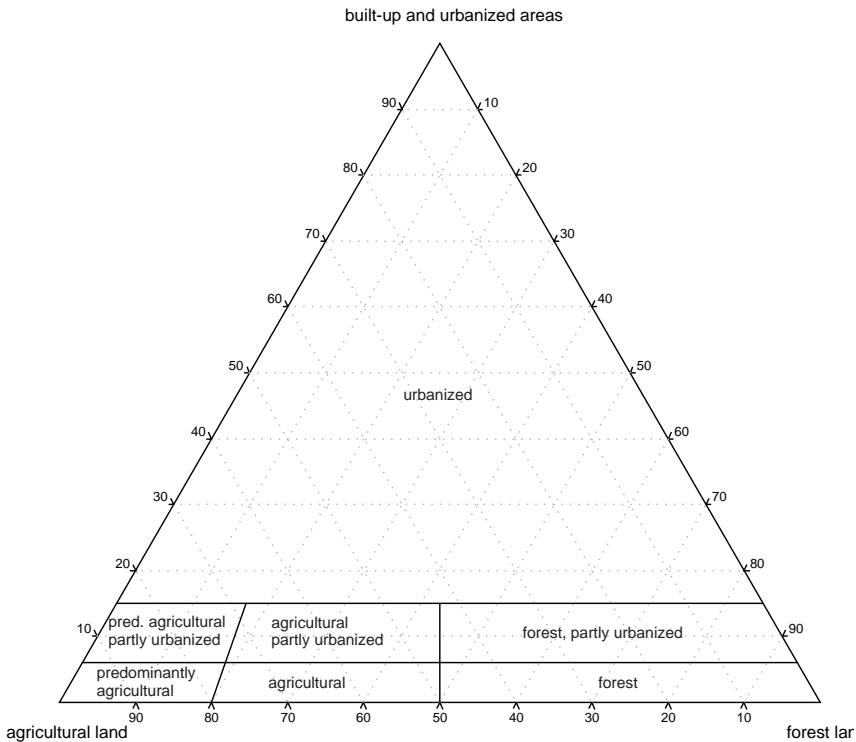
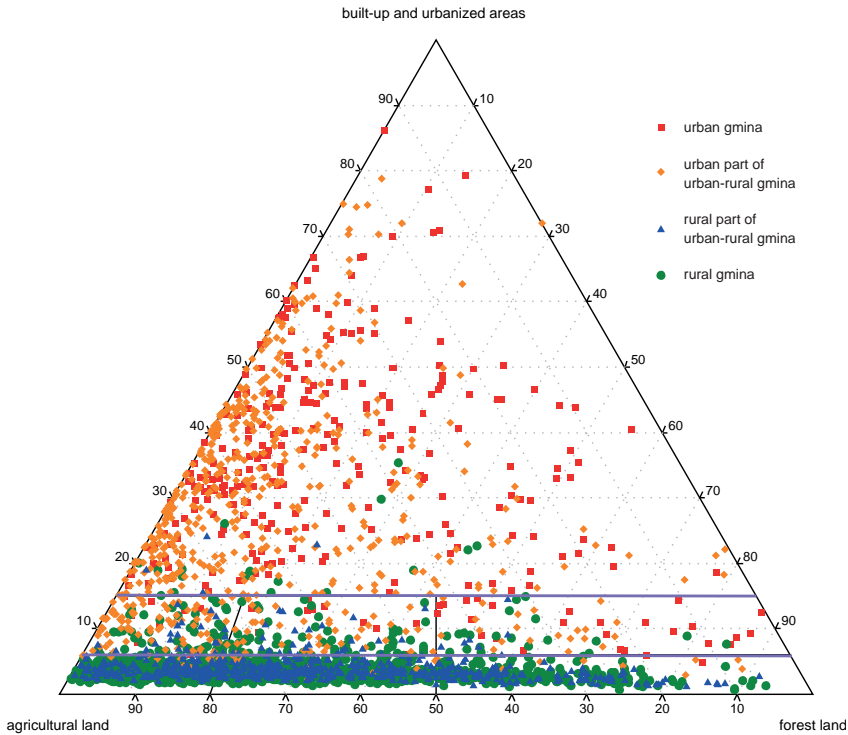


Figure 3. Trilinear-diagram of spatial classification.



**Figure 4.** Results of spatial classification on a trilinear diagram.

hand, around some big cities, like Lublin and Olsztyn, a sharp transition occurs between urbanized and non-urbanized zones. Vast partly urbanized areas can also be clearly observed, for example: the surrounding areas of Lubin, Konin and Bolesławiec, which have originated as a result of open-pit mining.

In comparison to population density, which is the sole indicator in the Eurostat and OECD typologies, some positive changes can be found. The difference in size of suburbanization zones between Poznań (552,000 inhabitants) and Nowy Sącz (85,000 inhabitants) is not visible in these typologies. Our classification emphasizes the difference. For the last 20 years many Poznań citizens have moved to gminas around the city. As a result, the land use in these gminas has changed. A similar process did not occur so intensively in Nowy Sącz.

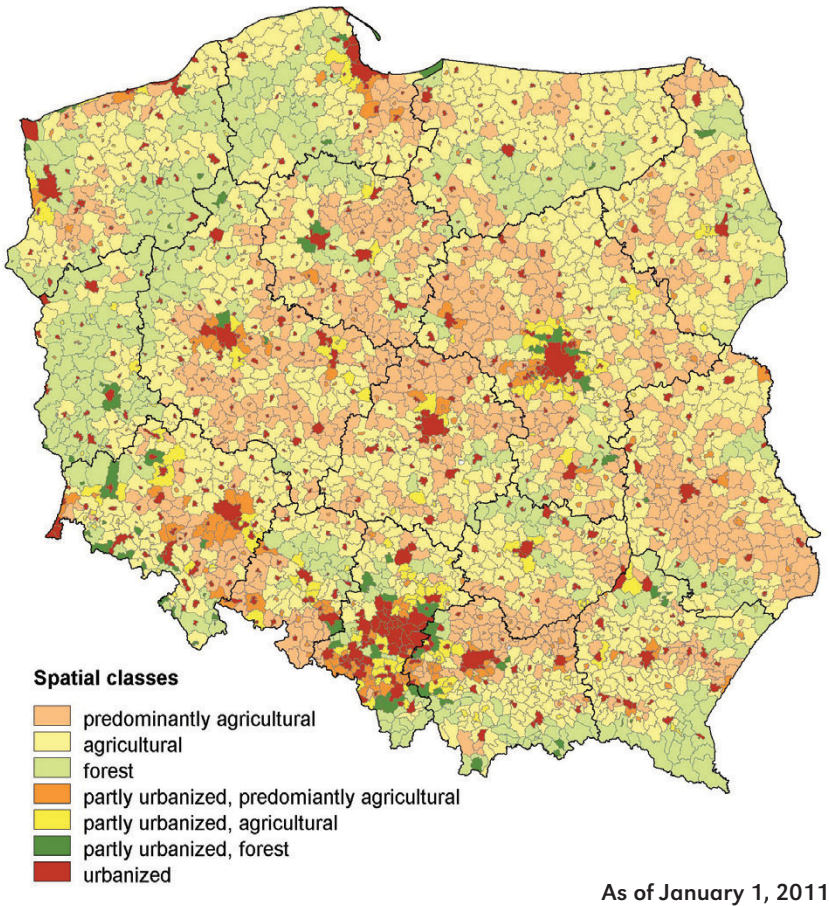
The division into 7 classes forms groups of units with different sizes and values of the basic statistical measures (Tab. 1). The largest group is the agricultural class (938 units), which represents 30.5% of all units in Poland, and are predominantly agricultural (711 units), 23.1%. Most of the population lives in urbanized areas – 21.6 million inhabitants, which is 56.6% of the population of Poland. The next largest, 10.1% of the population, live in partly urbanized areas and one third of residents live in non-urbanized areas. Urbanized units are areas with the highest population density – 1,360 inhabitants per km<sup>2</sup>. This number exceeds the population density in Polish cities by one fourth. The lowest population density occurs in forest

territories (31.2 inhabitants per km<sup>2</sup>). The predominantly agricultural units are nearly twice as densely populated (56.5 inhabitants per km<sup>2</sup>). Agricultural territories fall between them (47.6 inhabitants per km<sup>2</sup>). These results show that agriculture conduces settlement to a greater degree than forestry.

We have analyzed the relationship between the belonging of units to classes in spatial classification and to administrative groups. The model of full compliance assumes that all cities would be in urbanized or partly-urbanized classes. Towns with less than 5,000 residents would belong to partly-urbanized classes based on this assumption. On the other hand, the majority of rural areas would belong to those that are non-urbanized, and the minority of them, mostly those adjacent to big cities, in partly-urbanized classes.

Full compliance of both classifications does not occur (Tab. 2). In a group of 306 urban gminas 249 (81.4%) were classified as urbanized and 53 (17.3%) as partly-urbanized. Contrary to the compliance model, built-up and urbanized areas occupy less than 6% of the used area in 4 (1.3%) of urban gminas: Sulmierzyce in the Wielkopolskie voivodship and Brańsk in Podlaskie voivodship are classified as agricultural, whereas Kaley and Wisła in the Śląskie voivodship are classified as forest.

Similarly, in the case of the urban parts of urban-rural gminas, full compliance of both classifications does not occur. In this group, there is a majority of towns with less than 5,000



**Figure 5.** Results of spatial classification on a choropleth map.

residents, which cannot be classified as being urbanized. In a group containing 600 urban parts of urban-rural units, 257 (42.8%) were classified as urbanized. Moreover, 316 (52.7%) were classified as partly-urbanized, of which 214 were classified as predominantly agricultural, partly urbanized. However, there are 27 (4.5%) urban parts of urban-rural gminas in 12 voivodships whose space has a low degree of urbanization. The largest number of cities (7), which are classified as non-urbanized, are located in the Podlaskie voivodship. It is worth noting that among the 31 cities which were classified as non-urbanized, 10 of them received or obtained city rights within the last 20 years. Only one of the cities in this group has more than 10,000 citizens (Wisła), and 22 of them have less than 5,000 residents.

The opposite situation can be observed in the case of rural units. Gminas classified as being predominantly agricultural, agricultural and forest classes, fulfil the requirements of the compliance model. For 2,173 rural areas, 700 (32.2%) were classified as being predominantly agricultural units, 929 (42.8%) as

being agricultural units and 329 (15.1%) as forested units. Moreover, 197 (9.1%) rural units are assigned to partly-urbanized classes. These are not only rural areas surrounding big cities, but also territories that contain intensive industry or tourist infrastructure. There are also 15 rural gminas and 3 rural parts or urban-rural gminas in the urbanized class. These 18 territories represent only 0.8% of all the rural areas in Poland. There are various causes for the intensive urbanization in these particular cases. Gminas Andrespol and Ksawerów bordering with Łódź, Michałowice, and Raszyn bordering with Warsaw, Tarnowo Podgórne bordering with Poznań, Siechnice bordering with Wrocław, Buczkowice, Goczałkowice-Zdrój, Ornontowice, Świerklany, Świerklaniec in Śląskie voivodship, are intensively developing areas on the outskirts of big cities. The high degree of spatial and demographic urbanization ensures that the landscapes of these areas no longer resemble those typical for rural areas. In the gminas Kosakowo near Gdynia, Krościenko Wyżne near Krosno, and Rędziny near Częstochowa, the share of built-up and urbanized areas is high, not only as a result of

**Table 1.** Division of territorial units to spatial classes (2010).

Spatial classes	Number of territorial units		Population		Area		Population density
	total	%	total (thous.)	%	km <sup>2</sup>	%	
Urbanized	524	17.0	21,636	56.6	15,905	5.1	1,360
Predominantly agricultural party urbanized	311	10.1	1,728	4.5	8,613	2.8	201
Agricultural party urbanized	168	5.5	1,394	3.7	9,783	3.1	142
Forest party urbanized	87	2.8	738	1.9	4,257	1.4	173
Predominantly agricultural	711	23.1	4,388	11.5	77,713	24.9	56
Agricultural	938	30.5	6,353	16.6	133,481	42.7	48
Forest	340	11.0	1,962	5.1	62,972	20.1	31
Total <sup>1</sup>	3,079	100.0	38,200	100.0	312,679	100.0	122

<sup>1</sup>Lack of data for towns: Walbórz and Nowe Brzesko.

their proximity to the large city, but also as a consequence of the existence of the airport. Bogatynia, Kleczew and Sitkówka-Nowiny are places where a significant share of urbanized areas is caused by open pit mines. An isolated case is the gmina Mielno near Koszalin, where a high degree of urbanization is the result of intensive tourist development.

## Conclusions and implementation

Rural areas in Poland have been changing intensively over the last decade. The highest population growth rates in the period 2001-2010 were recorded in rural and urban-rural gminas within major agglomerations: e.g. in Jabłonna near Warsaw which has a growth rate of 169.3; in Dopiewo near Poznań which has 168.7; Kosakowo near Gdynia which has 146.3, etc. This demon-

strates the fast pace of urbanization. Moreover, the largest investment activity occurs in gminas surrounding the major cities: e.g. the increase of new dwellings in these gminas (2001-2010) is higher by 9.9 percentage point than in the surrounded cities.

It should be noted that the results attained do not include the diversity of natural conditions. The results outcomes also had limited connections with the socio-economic aspects of suburbanization and the functional development of communes. The presented results that highlight the variety of rural areas based on land use, which is the most visible effect of human activity, could help us to evaluate these changes.

The classification is based on two administrative sources of data, which ensures its proper coherence. The land use data portray the reality better than population density. Changes in land use are easy to observe in the space of Poland. The indicators used for

**Table 2.** Number of administrative units belonging to spatial classes (2010).

Class name	Number of territorial units				
	total	in which			
		urban gminas	urban parts of urban-rural gminas	rural parts of urban-rural gminas	rural gminas
Urbanized	524	249	257	3	15
Predominantly agricultural party urbanized	311	13	214	23	61
Agricultural party urbanized	168	12	69	26	61
Forest party urbanized	87	28	33	6	20
Predominantly agricultural	711	-	11	159	541
Agricultural	938	2	7	263	666
Forest	340	2	9	120	209
Total	3,079	306	600	600	1,573



the purpose of classification are intelligible for users. Data values are relatively stable through time and correlates with the data of socio-economic processes. The classification can be used by different users. The possibility of the merging and further division of classes enables us to adapt the classification into surveys with different sample sizes. There are many criteria, which can be used for the further division of classes. Urbanized class may easily be categorized based on population thresholds. Classification could be also enhanced by socio-economic criteria.

The spatial classification of rural areas allows one to compare territorial units with similar properties. Diversity of these units is a consequence of performing various functions. Gminas' authorities can find units in order to compare them with each other using this classification and other criteria (demographical, socio-economic). New divisions may also be used by national authorities for the purpose of strategy planning and then evaluation.

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