

QUANTIFYING THE IDENTIFICATION FACTORS OF SUSTAINABLE RURAL DEVELOPMENT: A CASE STUDY OF WIELKOPOLSKIE VOIVODESHIP

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Abstract. Sustainable rural development is a process of positive changes in the economic, social and environmental domain. This process enables the development or maintenance of agricultural functions and the simultaneous strengthening of non-agricultural functions. It improves the quality of life of the inhabitants of local communities and manages the environment with due care for the needs of future generations. The aim of this article is to identify the factors of sustainable rural development and to measure development with the factors identified in this study. The factors of sustainable development were identified by means of factor analysis. Sustainable development was measured with a synthetic measure. The data for analyses came from the Local Data Bank of the Central Statistical Office. The research enabled the identification of major factors of sustainable rural development: the demographic situation, economic and spatial cohesion and the state of environmental infrastructure.

Keywords: sustainable development, rural area, factor analysis, Wielkopolskie voivodeship

INTRODUCTION

Development is a process of positive changes, expressed by qualitative progress and quantitative increase. When considering the rural development, these processes take place beyond city limits or in towns functionally

related to agriculture. The functional approach to the subject matter of this research (rural areas) assumes that sustainable rural development is a process of positive economic, social and environmental changes which enable the development or maintenance of agricultural functions. Simultaneously, this process strengthens non-agricultural functions and improves the quality of life of the local population by managing the environment with due care to satisfy the needs of future generations¹.

The purpose of this paper was to identify the factors of sustainable rural development in the Wielkopolskie voivodeship. Measurements were performed at a local level (municipalities). The variables were selected based on statistical and substantive grounds². The factor analysis was used to identify the leading indicators of sustainable development. In parallel, the number of indicators was reduced.

¹ For an overview of definitions of sustainable development in terms of socioeconomic development, see the study by Stanny and Czarnecki (2011).

² The first measures of sustainable development were based on statistical criteria only (variation and correlations). Afterwards, in the 1980s, the substantive criterion was included due to the conceptualization of 'sustainable development' (Borys, 2005).

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METHOD

The research was conducted in rural municipalities and in rural areas or urban-rural municipalities of the Wielkopolskie voivodeship. The measurements took place in 2015. The first step of the research procedure involved an overview of sustainable development measures and of the outcomes of studies conducted at the local level. This resulted in an original list of indicators for specific domain types (Tables 1, 2, 3). The factor analysis was used to identify the factors of sustainable development. The procedure was carried out for each of the aforesaid domains.

The purpose of the factor analysis is to find a set of common factors and determine their relations with observable variables, so as to explain the structure of relations between observable variables. The resulting metatraits synthesize the input traits and reduce the set of information by identifying the factor which provide the largest amount of information (Parysek and Wojtasiewicz, 1979, p. 54; Czyż, 1971, p. 18).

The next step was to measure the sustainable development domain with the synthetic trait (see more: Bartkowiak and Pocza, 2012). The values of factors identified in the first step were assumed to be simple traits. The results were shown on spatial distribution maps.

RESULTS

The level of social domain in rural areas was determined with the use of variables belonging to three groups of conditions, i.e. the demographic situation, living standards and the population's activity. The variables and factor loadings are listed in Table 3. The factor analysis enabled the identification of four factors which jointly explained 62.9% of the variance. The highest loadings of the first factor were noted for the following traits: the children-to-elderly ratio, the migration balance and the living area per inhabitant. These traits refer to the demographic situation and can be used as a measure of the area's attractiveness to potential residents. As regards the other three factors, high loadings were recorded for only one variable. The second factor demonstrated a high loading for the variable referred to as "turnout in the 2010 local government elections" which proved to be strongly dependent (however, not above 0.7) on the variable labeled "foundations, associations and social organizations per 1,000 population." Both of the

above variables describe the social participation of local residents. This factor explained 12.6% of the variance. The third and fourth factors can be described as cultural because they were represented by the variables labeled "the number of cultural events per 1,000 population" and "culture and art expenses per inhabitant." Each of them explained 10.8% and 9% of the variance, respectively.

Figure 1 shows the spatial distribution of the first factor with the highest share in the variance (30.5%). The differentiated values of the factor reflect the spatial variability of the aspect under analysis. As shown by the diversification patterns, extremely high values of the factor were recorded in the areas influenced by the cities of Poznań, Leszno and Ostrów Wielkopolski and in the Nowy Tomyśl district. High values were also reported in the Wolsztyn, Śrem, Konin, Krotoszyn and Kępno districts. In turn, the lowest levels of the first factor were observed in the outlying municipalities of the Konin sub-region and single municipalities of the Leszno sub-region. The areas with high values of the first factor demonstrated a healthy demographic situation and were characterized by a favorable age structure of the population. The high positive migration balance proved that these areas were an attractive place to live. Despite the influx of people, the living space per person was above average, reflecting the development of housing, especially as regards new single-family houses. This trend was particularly strong in the Poznań agglomeration. Conversely, the demographic situation was completely different in the areas with low levels of the first factor, characterized by an old population. The deterioration of their demographic structures is due to out-migration. The living standard expressed by the average living space per person was much below average. This suggests that these areas were not attractive places to settle and live in, a condition which impeded the development of the housing function. Therefore, these locations could be referred to as demographically challenged (Rosner, 2012).

It is noteworthy that, in addition to healthy demographic conditions, the highly developed group of municipalities were characterized by average participation rates and high outlays for culture. In turn, old population and out-migration were characteristic of the municipalities at the opposite side of the diversification scale. In this case, the population's activity was above average, and the budget allocated to culture, arts and sports was low.

According to the research assumptions, the social governance in rural areas of Wielkopolskie voivodeship

Table 1. Factor loadings for the social domain
Tabela 1. Ładunki czynnikowe dla ładu społecznego

Indicator Wskaźnik	Factor 1 Czynnik 1	Factor 2 Czynnik 2	Factor 3 Czynnik 3	Factor 4 Czynnik 4
Demographic situation Sytuacja demograficzna				
Females per 100 males (25–35 years old) Wskaźnik feminizacji (25–35 lat)	0.671	0.067	–0.074	0.100
Children-to-elderly ratio Relacja dzieci-starzy	0.739	0.333	0.223	0.019
Population growth (per 1,000 population) Przyrost naturalny na 1000 ludności	0.682	0.391	0.214	0.077
Migration per 1,000 population Saldo migracji na 1000 osób	0.881	0.034	–0.128	–0.074
Living conditions Warunki życia				
Social assistance expenditure per capita (PLN) Wydatki na pomoc społeczną na 1 mieszkańca (zł)	–0.670	–0.275	0.092	0.014
Physical culture and sports expenditure per capita (PLN) Wydatki na kulturę fizyczną i sport na 1 mieszkańca (zł)	–0.042	0.114	0.643	–0.474
Culture and art expenditure per capita (PLN) Wydatki na kulturę i sztukę na 1 mieszkańca (zł)	0.030	–0.042	–0.052	–0.881
Average useable floor space per person (sq.m.) Powierzchnia mieszkalna na 1 mieszkańca (m ²)	0.744	–0.322	–0.111	–0.332
Population's activity Aktywność mieszkańców				
Voter turnout (%) Frekwencja wyborcza w wyborach samorządowych (%)	0.010	–0.812	0.149	0.084
Local government councilors with tertiary, post-secondary or secondary level of education (%) Udział radnych ze średnim i wyższym wykształceniem (%)	0.292	0.414	0.205	–0.049
Associations and other social organizations per 1,000 population Fundacje, stowarzyszenia i organizacje społeczne na 1000 mieszkańców	–0.172	–0.618	0.004	–0.130
Cultural events per 1,000 population Liczba imprez kulturalnych na 1000 mieszkańców	–0.066	–0.116	0.822	0.205
Variance explained (%) Odsetek wyjaśnianej wariancji (%)	30.5	12.6	10.8	9.0

Source: own calculations based on Statistica.
 Źródło: obliczenia własne z wykorzystaniem programu Statistica.

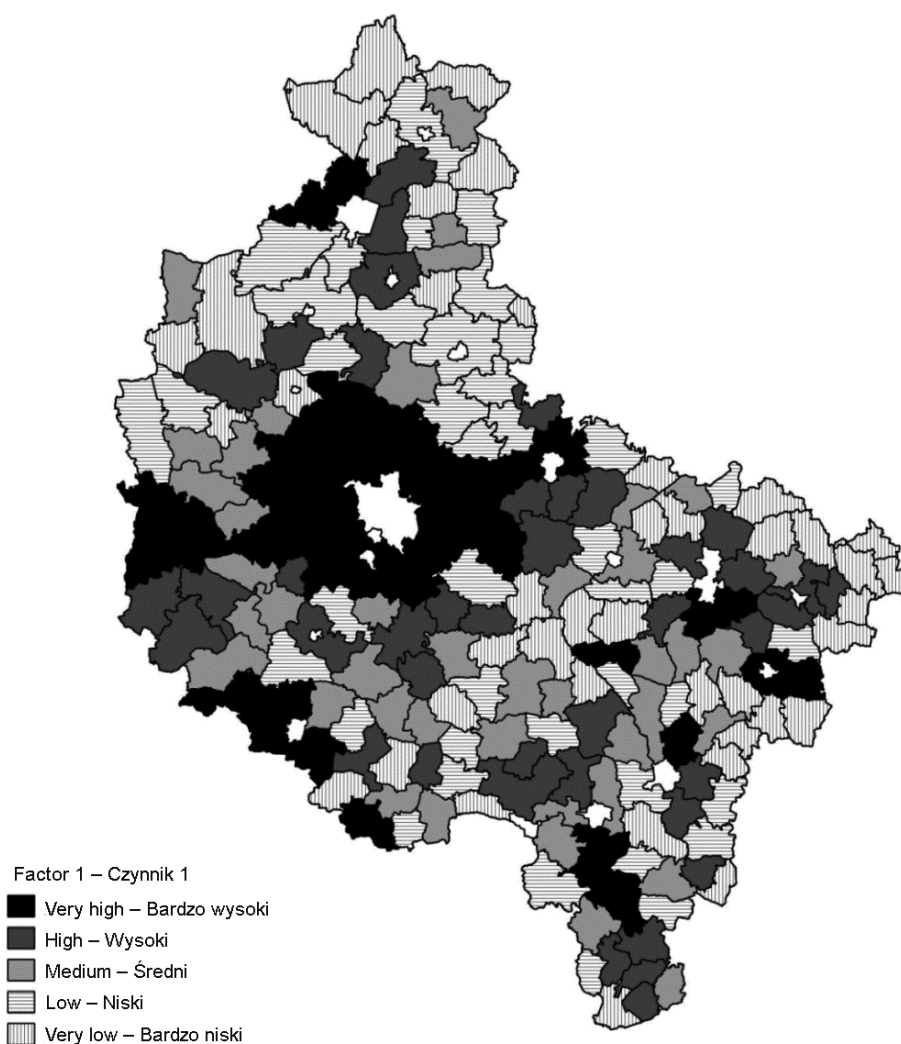


Fig. 1. Spatial distribution of factor 1 for social domain in rural areas of the Wielkopolskie voivodeship in 2015

Source: own calculations based on Statistica.

Rys. 1. Rozkład przestrzenny czynnika 1 dla ładu społecznego obszarów wiejskich województwa wielkopolskiego w 2015 r.

Źródło: obliczenia własne z wykorzystaniem programu Statistica.

was measured using the values of the factors identified in this study. Figure 2 shows the spatial diversity of the group under consideration. The measurement enabled the identification of five equinumerous groups of areas with different levels of social domain. The result was similar to the diversification of the first factor.

The conditions affecting agricultural and non-agricultural activity are important for the economic

development of rural areas because they also affect local finances. Therefore, the economic domain area was identified and measured according to the original list of indicators provided for in this study (Table 2).

In the factor analysis, four factors were identified which jointly explained 65.3% of variance. The first factor had the highest loadings for the following traits: own income per capita and transport expenses per inhabitant.

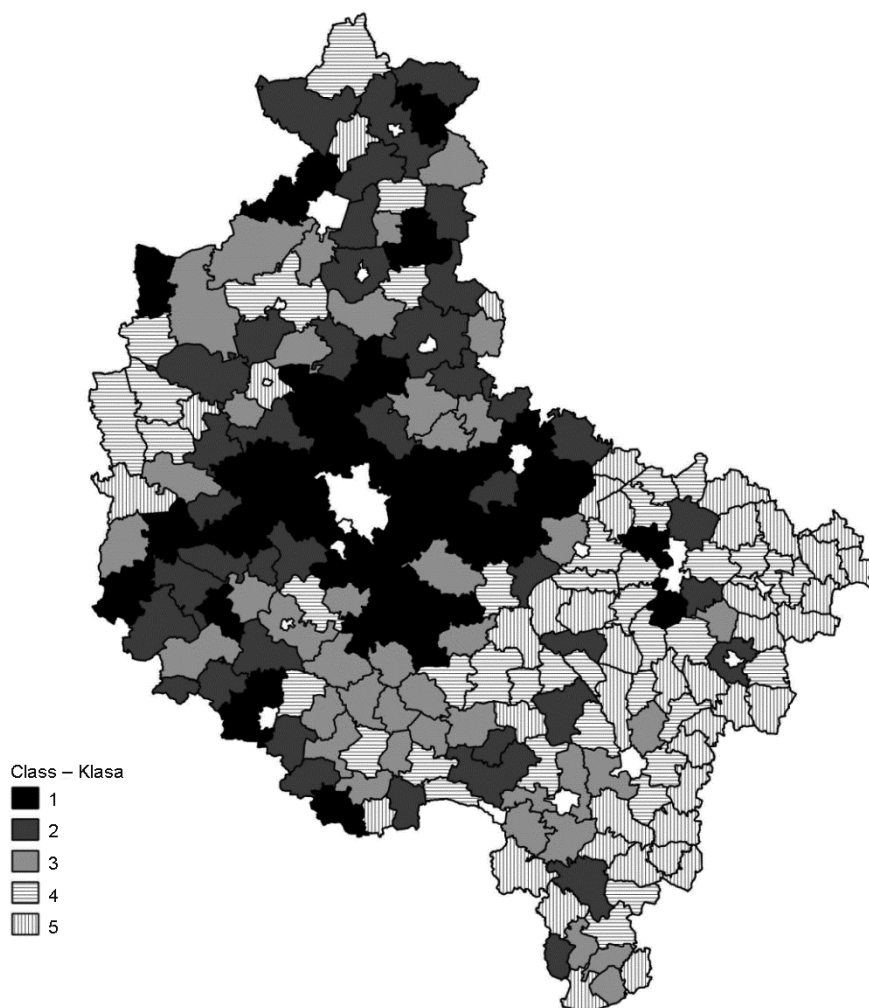


Fig. 2. Social domain in rural areas of the Wielkopolskie voivodeship in 2015

Source: own calculations based on Statistica.

Rys. 2. Ład społeczny obszarów wiejskich województwa wielkopolskiego w 2015 r.

Źródło: obliczenia własne z wykorzystaniem programu Statistica.

The first trait affects the financial independence of the municipality. The second trait can be a measure of spatial cohesion at a local level, and may be defined as entrepreneurship because it has high loadings of the entrepreneurship indicator and of individual farm area. The third factor, defined as the investment activity of local authorities, had high loadings of the following traits: the share of investments in total expenses and the value of EU funds per inhabitant. The last factor, defined as spatial accessibility, was characterized by a high load of

the trait referred to as “location vs. transport hubs.” The loading and sign of the factor should be interpreted as follows: low spatial accessibility goes along with poor economic domain.

Figure 3 shows the spatial diversification of the first factor which had the greatest share in the variance explained. Accordingly, the highest values were noted in the Poznań agglomeration, in selected municipalities within the impact area of former voivodeship capitals and in the Kępno district. In turn, the lowest values were

Table 2. Factor loadings for economic domain
Tabela 2. Ładunki czynnikowe dla ładu gospodarczego

Indicator – Wskaźnik	Factor 1 Czynnik 1	Factor 2 Czynnik 2	Factor 3 Czynnik 3	Factor 4 Czynnik 4
Agriculture and economic activity Sektor rolniczy i aktywność ekonomiczna				
Number of economic operators entered to the REGON register per 1,000 population Liczba podmiotów gospodarczych zarejestrowanych w REGON na 1000 mieszkańców	0.421	0.787	0.056	0.043
Average area of private farms beyond 1 ha of agricultural land Średni obszar gospodarstwa indywidualnego powyżej 1 ha UR	-0.060	0.812	-0.124	-0.018
Livestock units per 100 ha of agricultural land Obsada zwierząt (w sztukach dużych) na 100 ha UR	0.095	0.155	0.416	0.577
Location rent (agriculture and non-agricultural activities) Renta położenia (rolnictwo i działalność pozarolnicza)				
Soil quality indicator (score) Jakość Rolniczej Przestrzeni Produkcyjnej (pkt)	0.020	0.683	0.067	0.162
Restrictions in preservation areas (score) Ograniczenia gospodarcze (pkt)	0.115	-0.480	-0.060	0.161
Proximity of transport hubs (score) Położenie względem węzłów komunikacyjnych (pkt)	0.121	0.043	0.174	-0.748
Distance to cities (score) Położenie względem miast (pkt)	0.641	0.089	0.209	-0.478
Local finances Finanse lokalne				
Share of income tax (corporate income tax and personal income tax) in total incomes (%) Udział podatków PIT i CIT w dochodach ogółem (%)	0.690	0.268	0.326	-0.385
Own income per capita (PLN) Dochody własne na 1 mieszkańca (zł)	0.827	0.039	-0.257	-0.015
Share of investments in total expenditures (%) Wydatki inwestycyjne w ogóle wydatków (%)	0.334	0.028	-0.775	-0.024
EU funds per capita (PLN) Wartość pozyskanych środków UE na 1 mieszkańca (zł)	-0.168	-0.023	-0.846	0.128
Transport expenditures per capita (PLN) Wydatki na transport na 1 mieszkańca (zł)	0.818	-0.188	-0.053	0.126
Variance explained (%) Odsetek wyjaśnianej wariancji (%)	24.9	16.6	14.5	9.3

Source: own calculations based on Statistica.
 Źródło: obliczenia własne z wykorzystaniem programu Statistica.

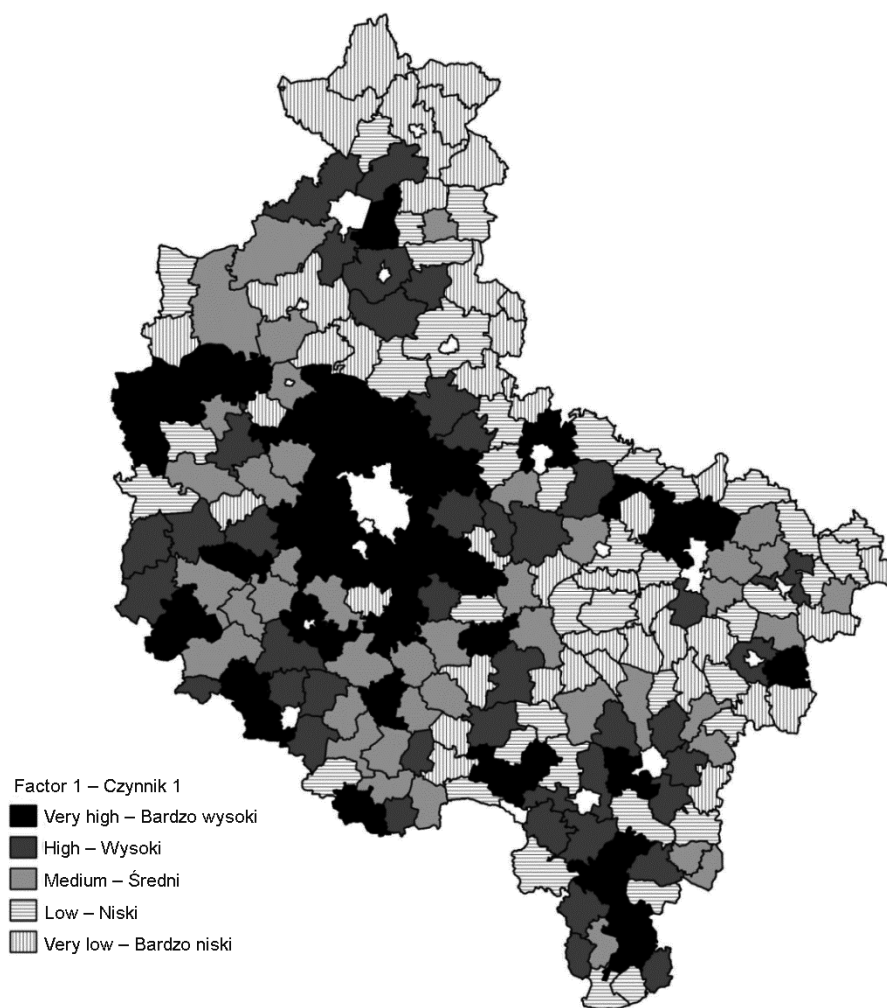


Fig. 3. Spatial distribution of factor 1 for economic domain in rural areas of the Wielkopolskie voivodeship in 2015

Source: own calculations based on Statistica.

Rys. 3. Rozkład przestrzenny czynnika 1 dla ładu gospodarczego obszarów wiejskich województwa wielkopolskiego w 2015 r.

Źródło: obliczenia własne z wykorzystaniem programu Statistica.

recorded in the northern part of the region and in the Konin sub-region. The first group of areas demonstrated high levels of own income and high transport expenses, contrary to the second group. The areas with high values of the first factor enjoyed a very favorable location (the location rent: the Poznań agglomeration, located near a trunk road). However, only some entities managed to reap the related benefits.

Factor values were used to measure the economic domain, as shown in Figure 4. The spatial diversification is relatively clear: the group with the highest levels of economic domain consisted of municipalities located in the Poznań agglomeration (the first and second ring) and municipalities with a highly developed agricultural sector (the Leszno sub-region). Konin sub-region municipalities formed a compact group with low economic

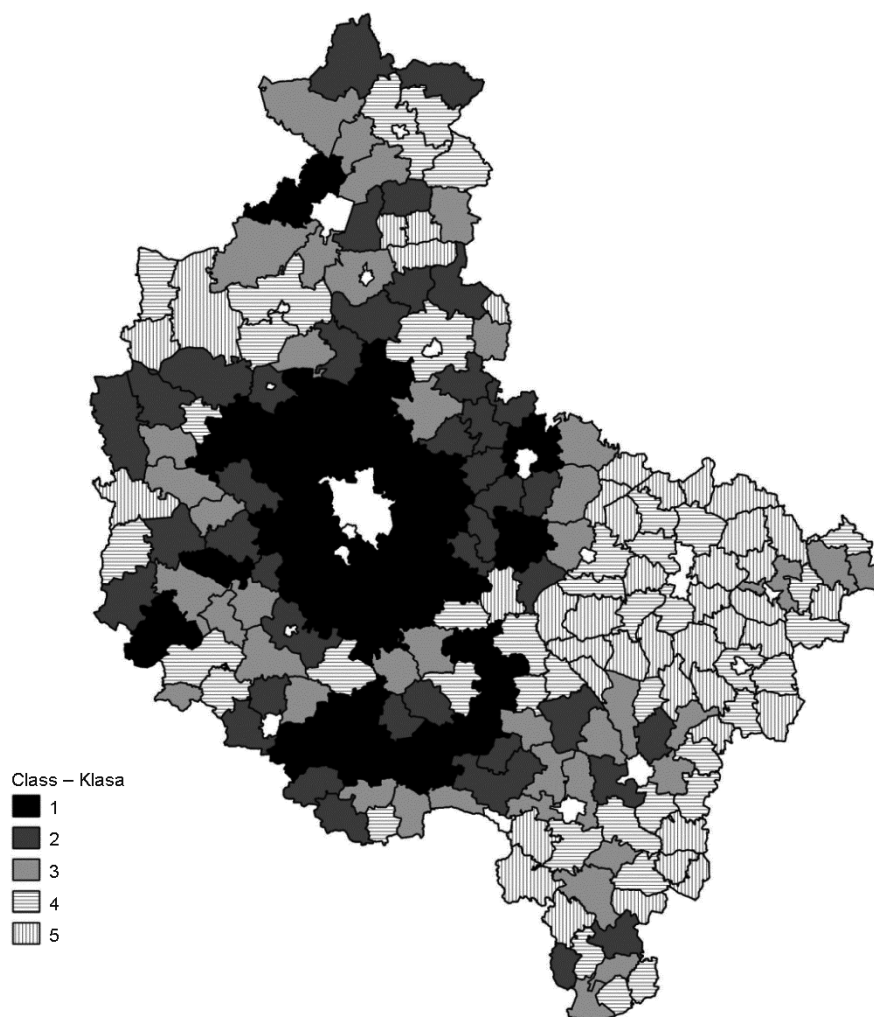


Fig. 4. Economic domain in rural areas of the Wielkopolskie voivodeship in 2015.

Source: own calculations based on Statistica.

Rys. 4. Ład gospodarczy obszarów wiejskich województwa wielkopolskiego w 2015 r.

Źródło: obliczenia własne z wykorzystaniem programu Statistica.

domain levels. Also, poor economic domain was reported in several individual municipalities.

The areas with very high and high economic domain levels were characterized by a good location rent. The population's entrepreneurship levels were above average. As the local authorities' own income was twice higher, they were able to make investments above the average level. The potential of these areas was strengthened by their location and by the local authorities' policy. On the other hand, there were growing development

disparities, as can be seen at the other end of the diversification scale. Municipalities in the lowest classes demonstrated low spatial accessibility levels, worse natural conditions for the agricultural development, and greater agrarian fragmentation. As a consequence, the investment potential of local governments was lower. It was reflected, in particular, by the amounts of investments and funds accessed from external sources. These limitations exacerbate the differences in development levels.

Table 3. Factor loadings for environmental domain
Tabela 3. Ładunki czynnikowe dla ładu środowiskowego

Indicator – Wskaźnik	Factor 1 Czynnik 1	Factor 2 Czynnik 2
Location rent (rural tourism) Renta położenia (turystyka wiejska)		
Legally protected valuable natural areas (% of total area) Obszary cenne przyrodniczo (% powierzchni gminy)	-0.022	0.001
Tourism attractiveness (score) Wskaźnik walorów turystycznych (pkt)	0.115	0.742
Soil quality indicator (score) Położenie względem zbiorników wodnych (pkt)	0.053	0.101
Forest coverage ratio (%) Udział lasów w powierzchni ogółem (%)	-0.017	0.625
Share of permanent grassland in the agricultural land (%) Udział TUZ w UR (%)	-0.163	0.072
Environmental infrastructure Infrastruktura ochrony środowiska		
Population served by wastewater treatment plants Ludność obsługiwana przez oczyszczalnie ścieków	0.946	0.053
Water supply network length (km per 100 sq. km) Długość sieci wodociągowej na 100 km ²	0.153	-0.853
Sewerage network length (km per 100 sq. km) Długość sieci kanalizacyjnej na 100 km ²	0.827	-0.262
Sewerage network connections per 100 water supply network connections Połączenia kanalizacyjne na 100 połączeń wodociągowych	0.934	0.110
Variance explained (%) Odsetek wyjaśnianej wariancji (%)	31.0	23.0

Source: own calculations based on Statistica.

Źródło: obliczenia własne z wykorzystaniem programu Statistica.

The measurement of the environmental domain took account of environmental parameters which are significant to the development of tourism and of the environmental infrastructure. Two factors were identified which jointly explained 54% of the variance (Table 3). The first factor had high loadings for the following traits: population served by sewage treatment plants; length of the sewage system; and the ratio between the lengths of the sewage system and of the water supply system. Figure 5 shows the diversification of the infrastructural factor. The highest values were noted in municipalities of the Poznań agglomeration and in those located in the

vicinity of sub-regional cities. The lowest values of the factor were recorded in outlying areas and inside the region. The diversification was not clear. There were high loadings of the second factor for the following variables: the tourism indicator and the length of the water supply system per 100 sq. km. Thus, the factor can be defined as tourism attractiveness.

Figure 6 shows the summative value of environmental domain levels. The diversification is rather difficult to interpret. The group of municipalities with high environmental domain levels included those very attractive to tourists (the districts of Złotów, Piła, Nowy

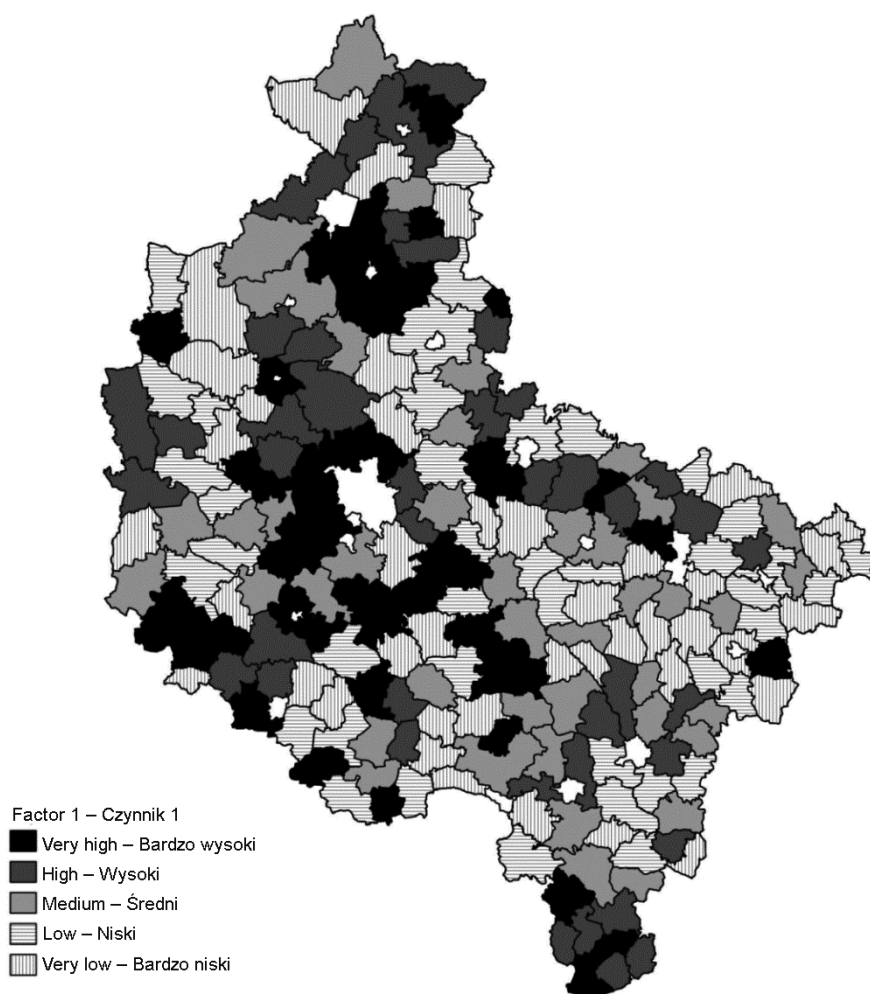


Fig. 5. Spatial distribution of factor 1 for environmental domain in rural areas of the Wielkopolskie voivodeship in 2015

Source: own calculations based on Statistica.

Rys. 5. Rozkład przestrzenny czynnika 1 dla ładu środowiskowego obszarów wiejskich województwa wielkopolskiego w 2015 r.

Źródło: obliczenia własne wykorzystaniem programu Statistica.

Tomyśl and Wolsztyn) as well as those which, while deprived of any tourist attractions, were equipped with the environmental infrastructure (Kępno district). Particular caution should be exercised when interpreting the results of the environmental domain analysis. There were numerous groups of municipalities with poor environmental domain in the Konin sub-region. Their characteristic features were the low density of the environmental infrastructure and low attractiveness of natural space.

CONCLUSIONS

The research enabled the identification of the main determinants of sustainable rural development. The demographic situation, reflected by the age structure and living standards, was the main factor contributing to social domain. The results confirmed that social domain primarily depends on demographic processes. The traits defining the economic cohesion (own income per inhabitant) and spatial cohesion (transport expenses per inhabitant)

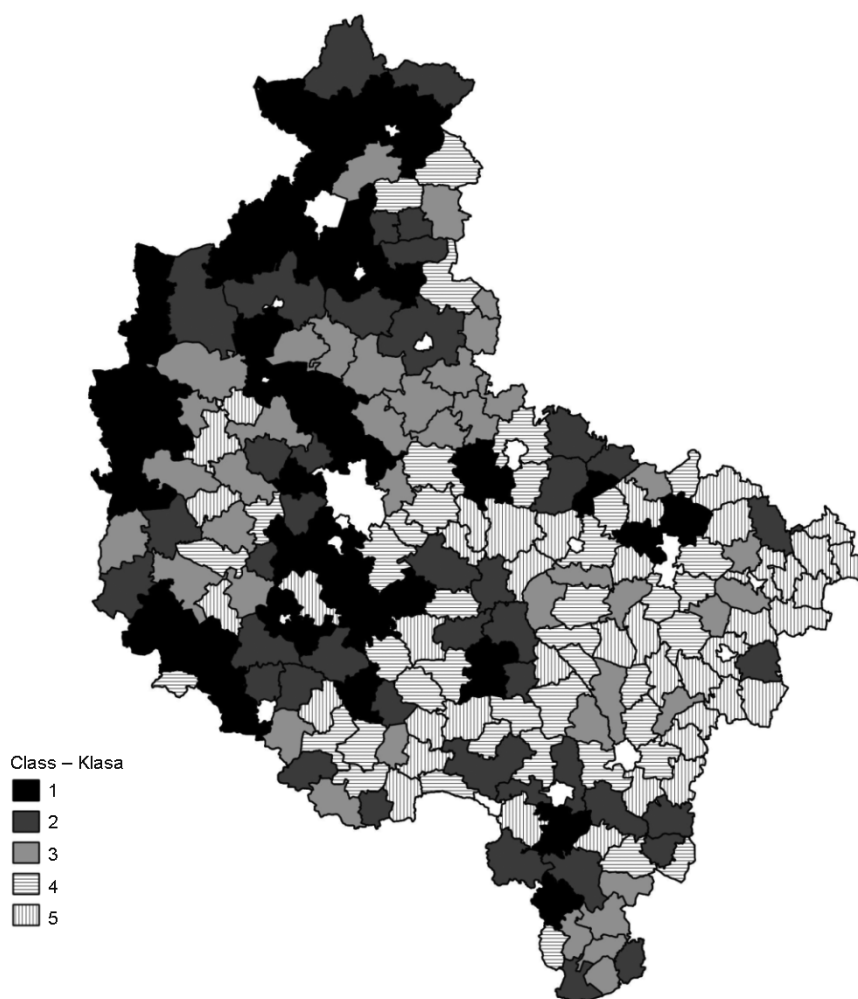


Fig. 6. Environmental domain in rural areas of the Wielkopolskie voivodeship in 2015
Source: own calculations based on Statistica.

Rys. 6. Ład środowiskowy obszarów wiejskich województwa wielkopolskiego w 2015 r.

Źródło: obliczenia własne z wykorzystaniem programu Statistica.

were covered by the main factor of economic domain. Environmental domain was mostly affected by the condition of the environmental infrastructure.

The results of sustainable development measurements showed that economic development was accompanied by a high level of social domain. However, there was no straight correlation between the two.

In the Wielkopolskie voivodeship, rural areas at high sustainable development levels were mostly found in the territories influenced by the cities of Poznań, Kalisz

and Leszno. Deficits in each of the domain types under analysis were mostly observed in the municipalities of the Konin sub-region. Also, spatial deficits in outlying areas were discovered.

These areas should be given special attention by regional authorities. In addition to financial support, they also require substantive support which means facilitating the management of local development measures, e.g. by initiating projects for municipalities with common developmental needs.

This research should be continued by extending and modifying the list of indicators. Poorly represented aspects, including without limitation the environment, need to be extended. While the lack of NTS 5 data for the municipalities is a limitation, it does not mean the research should be discontinued.

REFERENCES

- Bartkowiak, N., Poczta, W. (2012). Czynniki rozwoju obszarów wiejskich w Wielkopolsce. Poznań: Wyd. UP w Poznaniu.
- Borys, T. (2005). Wskaźniki zrównoważonego rozwoju. Białystok: Wyd. Ekonomia i Środowisko.
- Czyż, T. (1971). Zastosowanie metody analizy czynnikowej do badania ekonomicznej struktury regionalnej Polski. Wrocław: Ossolineum.
- Local Data Bank (n.d.). Retrieved from: https://bdl.stat.gov.pl/BDL/start?p_name=indeks.
- Parysek, J. J., Wojtasiewicz, L. (1979). Metody analizy regionalnej i metody planowania regionalnego. Warszawa: PWN.
- Rosner, A. (2012). Zmiany rozkładu przestrzennego zaludnienia obszarów wiejskich. Warszawa: IRWiR PAN.
- Stanny, M., Czarnecki, M. (2011). Zrównoważony rozwój obszarów wiejskich Zielonych Płuc Polski. Próba analizy empirycznej. Warszawa: IRWiR PAN.

IDENTYFIKACJA CZYNNIKÓW ZRÓWNOWAŻONEGO ROZWOJU OBSZARÓW WIEJSKICH. PRÓBA KWANTYFIKACJI NA PRZYKŁADZIE WOJEWÓDZTWA WIELKOPOLSKIEGO

Streszczenie. Zrównoważony rozwój obszarów wiejskich to proces pozytywnych zmian zachodzących w obszarze ładu gospodarczego, społecznego i środowiskowego. Pozwala on na rozwój lub podtrzymanie funkcji rolniczych przy jednoczesnym wzmacnianiu funkcji pozarolniczych, umożliwiając poprawę jakości życia mieszkańców społeczności lokalnych i gospodarując środowiskiem z troską o zaspokojenie potrzeb przyszłych pokoleń. Celem artykułu jest identyfikacja czynników zrównoważonego rozwoju obszarów wiejskich województwa wielkopolskiego oraz jego pomiar z wykorzystaniem tych czynników. Do identyfikacji czynników zrównoważonego rozwoju posłużono się analizą czynnikową. Pomiar zrównoważonego rozwoju wykonano miarą syntetyczną. Dane pozyskano z Banku Danych Lokalnych GUS. Przeprowadzone badania pozwoliły na wskazanie wiodących czynników zrównoważonego rozwoju obszarów wiejskich, takich jak: sytuacja ludnościowa (demograficzna), spójność ekonomiczna i przestrzenna oraz stan infrastruktury środowiska.

Słowa kluczowe: zrównoważony rozwój, obszary wiejskie, analiza czynnikowa, województwo wielkopolskie

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