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AN ANALYSIS OF THE DEVELOPMENT OF TECHNICAL INFRASTRUCTURE IN THE SOUTH-EAST OF POLAND

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Abstract

In this paper was analyzed selected components of technical infrastructure functioning in rural areas of the Malopolska, Świętokrzyskie and Podkarpackie Voivodships. The level of equipping rural areas with specified infrastructure elements was evaluated in the form of density and availability of infrastructure components. The work has been specified the rate of change in the analyzed indicators. In each of the provinces was separated 4, homogeneous groups of municipalities due to the level of infrastructure and standard of living. The lack of consistency in the level of the dynamics of the development of infrastructure with the dynamics of the percentage of residents using the equipment was noted. A positive phenomenon is that the development of the sewage system in all three voivodships has a higher average rate than the average rate of the development of the water supply system. This is particularly important due to the significant underdevelopment of the sewage system in relation to the water supply system.

Key words: infrastructure, rural areas, development

INTRODUCTION

Technical infrastructure is a rudimentary element in determining the development of certain areas. It performs a variety of functions including localization,

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integration and accelerative functions which determine the economic situation and living conditions of local communities (Pawełek 2015, Sikora *et al*. 2013). For this reason, it plays a significant role in the restructuring of rural areas (Nijkamp 1986). The relationships between the quality of the infrastructure environ and the standard of living of the rural population are types of feedback (Bergel *et al.* 2013, Krakowiak-Bal 2009, Salamon and Krakowiak-Bal 2013).

In the case of rural areas, technical infrastructure not only affects the development of the agricultural sector, but also creates and enhances inhabitants' interest in non-agricultural activities. Roads, communication systems, power grid, water supply, sewage disposal are the components of technical infrastructure which improve not only the standard of living, but also contribute to the increase in the investment attractiveness and effectively prevent the outflow of workers from rural areas. Infrastructure counteracts the processes of uneven development of regions which is noticeable, for example, in Poland (Salamon, 2010).

In the last few years a significant increase in the investment in technical infrastructure has been observed in Poland. This is related to the functioning of the Rural Development Programme 2007-2013, and the year 2014 was one of the last ones when these investments were made. In the years 2007-2014 the length of the water supply system increased by 35.4 thousand km, including more than 26.5 thousand km of the system built in rural areas. The number of connections increased by more than 749 thousand, including approx. 486 thousand in rural areas. In the same period the length of the sewage system increased by roughly 53.4 thousand km, including nearly 32 thousand km of system constructed in rural areas. This resulted in more than 946 thousand of new sewer connections, of which over 562 thousand built in rural areas (Municipal Infrastructure in 2014, 2015).

THE AIM, SCOPE AND METHOD OF THE STUDY

The main objective of the study was an attempt to carry out an analysis of selected components of technical infrastructure in rural areas of the Małopolskie, Świętokrzyskie and Podkarpackie Voivodships. 166 communities in Małopolska, 97 communities in the Świętokrzyskie Voivodship and 143 communities in the Podkarpackie Voivodship were analysed. Only rural communities and rural areas of urban-rural communities were studied. Statistical material came from the years 2008 – 2013 and took into account indicators related to water supply and sewerage. The level of equipping rural areas with specified infrastructure components was evaluated in the form of density that is the ratio of the length of the selected system to the surface area. Additionally, index values of availability of infrastructure components that is the ratio of the number of people using the system to the total number of people living in the area were calculated. The study

also employed indicators describing the standard (comfort) of life of the population associated with the studied infrastructure components – the percentage of houses with a bathroom, the percentage of flats equipped with a flushable toilet and water consumption per capita.

In order to group the communities with regard to the level of development of selected infrastructure components and standard of life indicators cluster analysis methods were employed: the agglomerative method in the first stage, whereas in the second stage – the k-means method (Sagan 2001, Kropsz 2003, Krakowiak-Bal 2005). The agglomerative method enabled to determine the number of clusters while objects were grouped with the use of the k-means method.

A comparison of changes that took place in the investigated period was also carried out. In order to execute this, the following dynamics indices were used :

- the average level of the examined phenomenon in the time series of moments,

$$\bar{y}_{ch} = \frac{\frac{1}{2}y_1 + y_2 + y_3 + \cdots + \frac{1}{2}y_n}{n-1}$$

where:
$y_1, y_2, \ldots, y_n$ – the size of the tested phenomenon at successive moments,
n – the number of tested moments.

- simple base indices relating to the fixed base comparison,

$$i_{t/0} = \frac{y_t}{y_0} \cdot 100$$

where:
y_t – the level of phenomenon over the given period of time,
y_0 – the level of phenomenon over the period of time adopted as the basis for comparisons.

- chain indices that relate the level of the phenomenon over the given period to the level immediately preceding it,

$$i_{t/t-1} = \frac{y_t}{y_{t-1}} \cdot 100$$

where:
y_t – the level of phenomenon over the given period of time,
y_{t-1} – the level of phenomenon over the period of time immediately preceding the studied period of time.

- the pace of change that is the ratio of the absolute increase to the size of the phenomenon from the preceding period (Makać and Urbanek-Krzysztofiak 1997).

$$T = \frac{y_t - y_{t-1}}{y_{t-1}} \cdot 100$$

where:
y_t – the level of phenomenon over the given period of time,
y_{t-1} – the level of phenomenon over the period of immediately preceding the studied period of time.

- the mean chain dynamics index,

$$\bar{\imath} = \sqrt[n-1]{\frac{y_1}{y_0} \cdot \frac{y_2}{y_1} \cdot \frac{y_3}{y_2} \ldots \frac{y_n}{y_{n-1}}} = \sqrt[n-1]{\frac{y_n}{y_0}}$$

where:
y_0 – the level of phenomenon over the period of time adopted as the basis for comparisons,
$y_1, y_2, y_3, \ldots, y_n$ – the value of the examined phenomenon (infrastructure indicator) in the following years

- the average rate of change,

$$\bar{T} = (\bar{\imath} - 1) \cdot 100$$

where:
$\bar{\imath}$ – the mean chain dynamic index of studied phenomenon (the selected component of infrastructure).

RESULTS

To carry out the agglomeration which was to indicate the number of clusters of surveyed objects, the complete linkage method was employed and as a measure of the distance between objects the Euclidean distance was adopted, showing the geometric distance in the multidimensional space. The results of this analysis are shown in Figures 1 – 3. The conducted analysis of clusters allowed to isolate 4 homogeneous, in view of the level of technical infrastructure development and standard of living, groups of communities in specified voivodships.

Table 1 lists the characteristics of each cluster i.e. their numerousness and mean values of the indicators adopted as a measure of infrastructure and standard of life of residents.

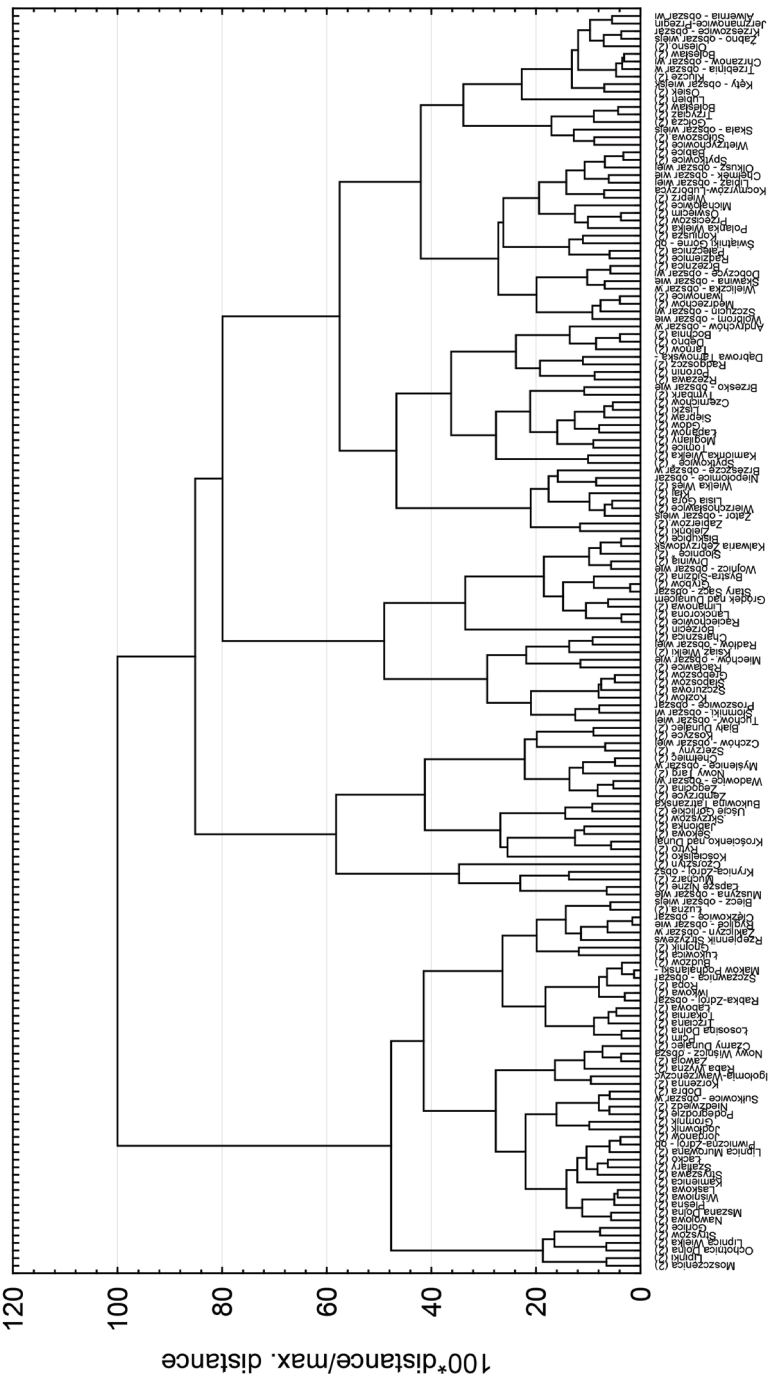

Figure 1. Dendrogram. The result analysis of cluster of communities in the Małopolskie voivodship in view of the quality level of technical infrastructure and standard of living.

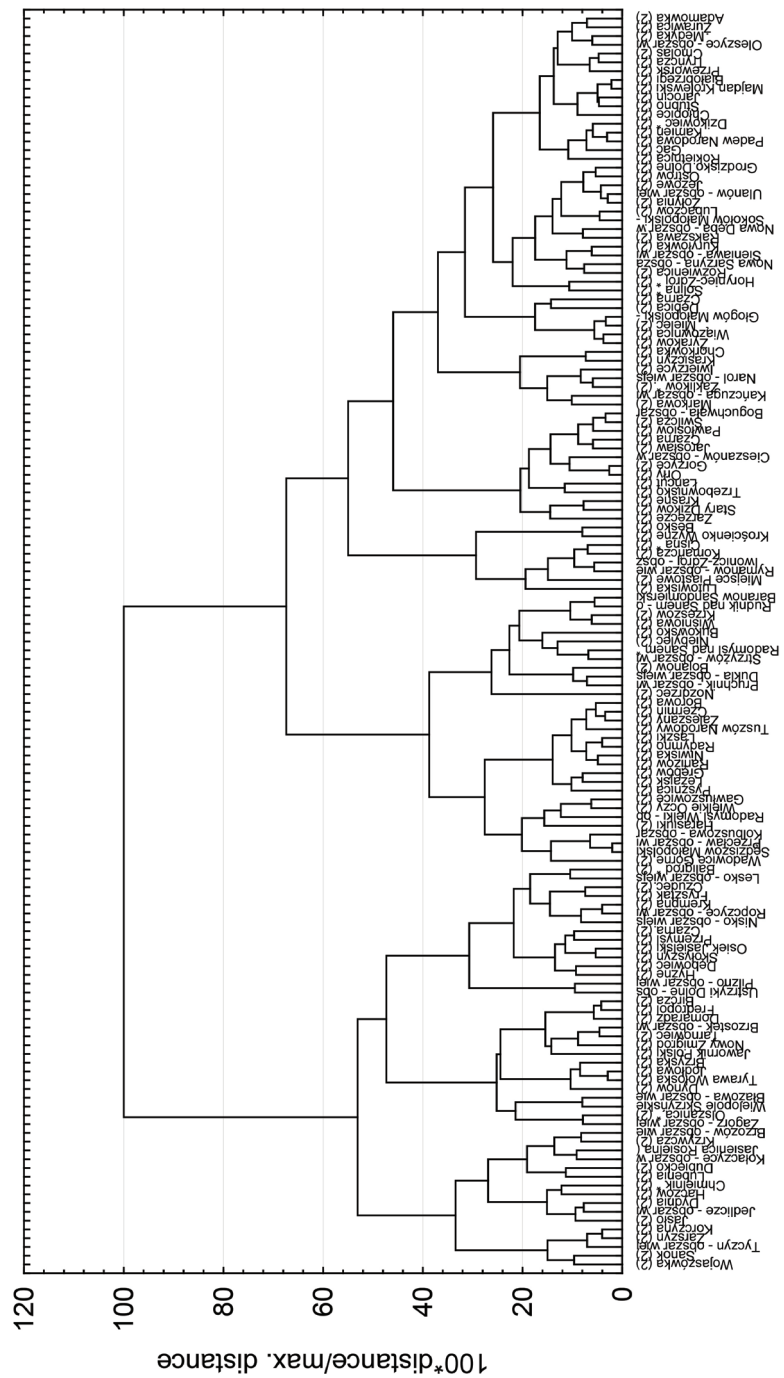

Figure 2. Dendrogram. The result analysis of cluster of communities in the Podkarpackie voivodship in view of the quality level of technical infrastructure and standard of living.

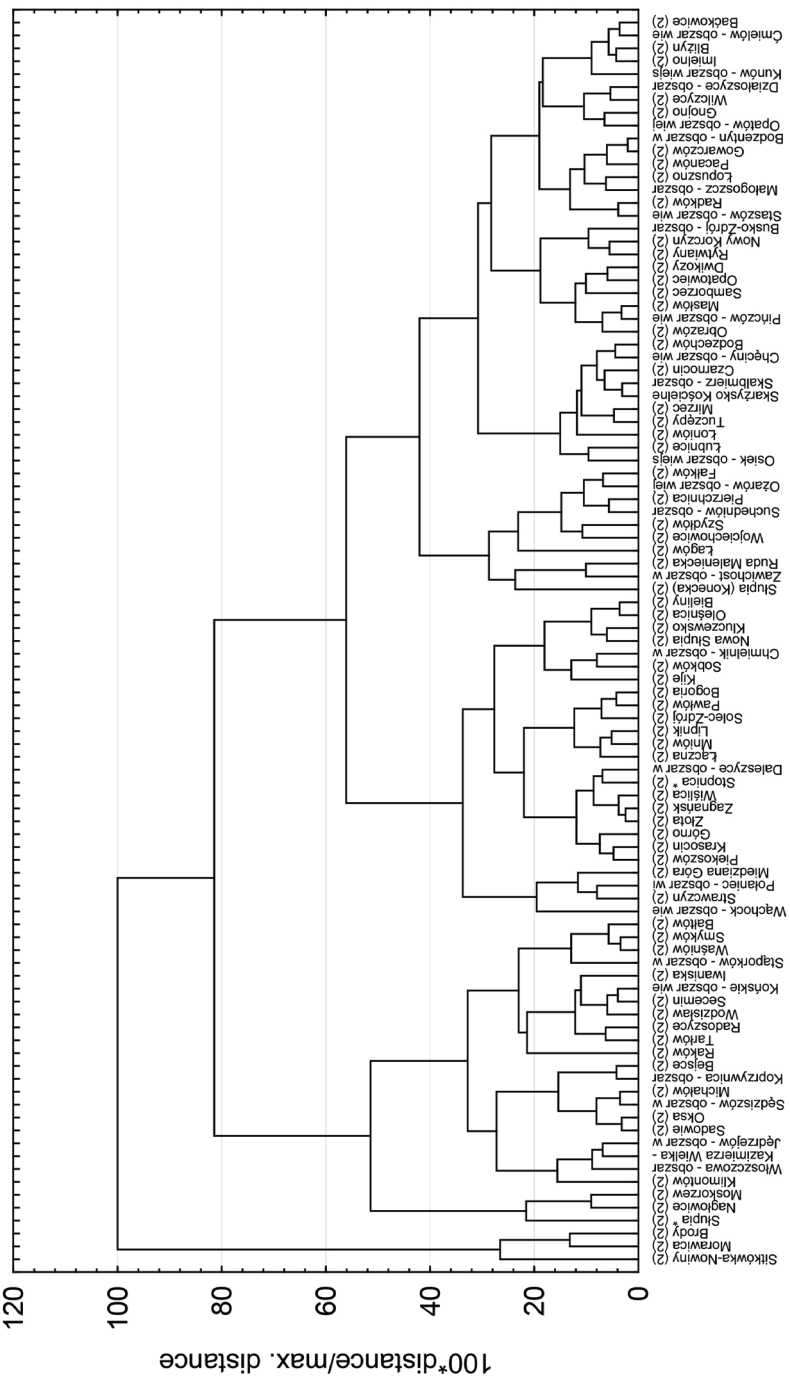

Figure 3. Dendrogram. The result analysis of cluster of communities in the Świętokrzyskie voivodship in view of the quality level of technical infrastructure and standard of living.

Figures 4 – 6 show graphs of the mean of each cluster with regard to the investigated infrastructure components and the standard of life indicators.

A preliminary analysis of the mean values shows that in each of the studied voivodships, there is a strong variation in the density of the water supply system and its availability, expressed as a percentage of the population using the water system. However, significant disparities in the density and accessibility of the sewage system were observed.

Table 1. Characteristics (numerousness and mean values) of individual clusters

Cluster	Numerousness	Mean value						
		density of the water supply system [km·100 km^{-2}]	density of the sewerage system [km·100 km^{-2}]	residents using water supply system [%]	residents using the sewerage system [%]	flats equipped with a bathroom [%]	flats equipped with a flushable toilet [%]	use of water[m^3/resident]
Małopolskie voivodship								
1	19	234.18	148.63	81.32	39.66	88.98	90.37	26.10
2	71	162.72	32.85	78.46	15.57	82.99	84.82	22.29
3	30	45.22	77.84	36.61	41.40	84.85	86.66	10.10
4	46	32.80	15.23	24.69	11.74	82.28	84.46	5.82
Świętokrzyskie voivodship								
1	48	77.01	8.70	67.66	9.54	64.57	66.33	17.73
2	19	94.12	40.75	81.40	34.69	70.59	72.75	20.98
3	21	156.16	11.65	76.72	8.22	68.00	69.44	21.08
4	9	147.22	94.09	88.66	47.11	78.85	79.90	23.20
Podkarpackie voivodship								
1	10	161.82	307.40	80.29	68.00	84.23	86.14	35.81
2	41	99.08	134.80	69.67	53.59	80.19	81.42	28.99
3	50	91.64	37.71	81.76	30.48	79.86	80.94	35.41
4	42	19.28	24.86	31.99	25.05	79.68	81.34	11.48

In the Malopolskie voivodship the first cluster, which included 19 communities has the greatest density of water and sewage systems. In this cluster availability of water supply system is similar to the second cluster, and the availability of the sewage system is at the level of the third cluster. In all the surveyed rural communes of the voivodship the mean value of the indicators describing the standard of life is at a similar level. A worrying phenomenon is a considerable disparity between the values of indicators connected to water supply in relation

to indicators of wastewater. Only in the third group of communities the density of the sewage system is greater than the density of the water supply system.

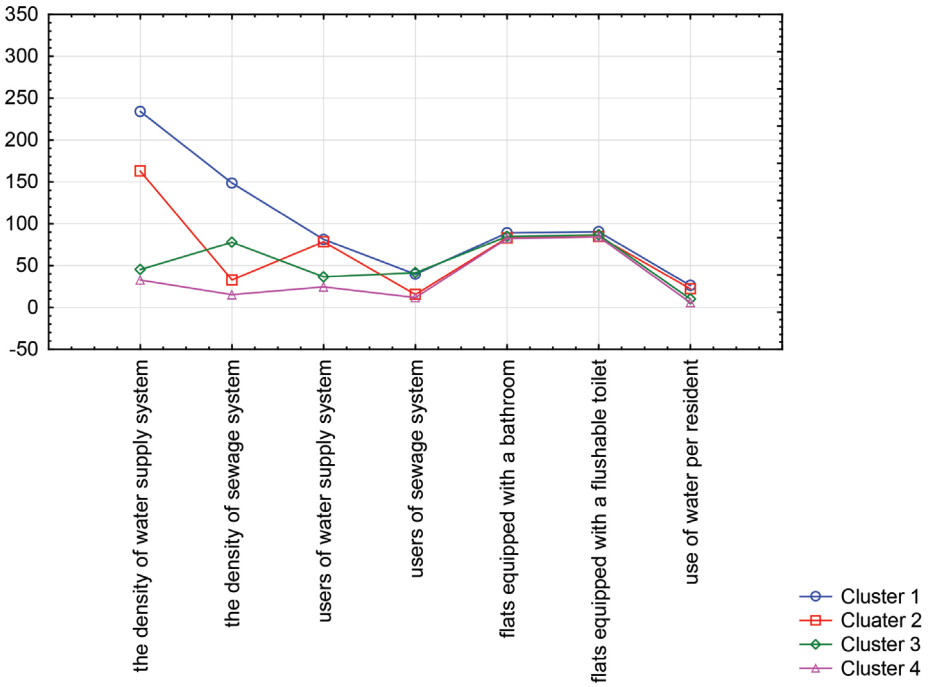

Figure 4. Mean values of each cluster with respect to the examined indicators of the technical infrastructure and the standard of living in the Malopolskie voivodship

The Świętokrzyskie voivodship shows even greater variation of quality of water supply and sewage infrastructure. For example, in the third cluster the density of the water supply system is over 150 km·100km^{-2} and the density of the sewage system is slightly above 11 km·100km^{-2}. The density of the sewage system in particular clusters varies widely and ranges from 8.7 km·100km^{-2} in the first cluster, which includes 48 communities, to 94 km·100km^{-2} in the fourth cluster (9 communities).

The communities of the Podkarpackie voivodship are differentiated primarily due to the density of the sewage system. The second factor influencing the discrimination of the examined objects is the density of the water supply system. The fourth group including 42 communities markedly stands out from the rest. It was noted that in the group the sewage system density slightly outweighs the density of the water system. The values of the standard of living in this region do not differ significantly from those in the other two voivodships.

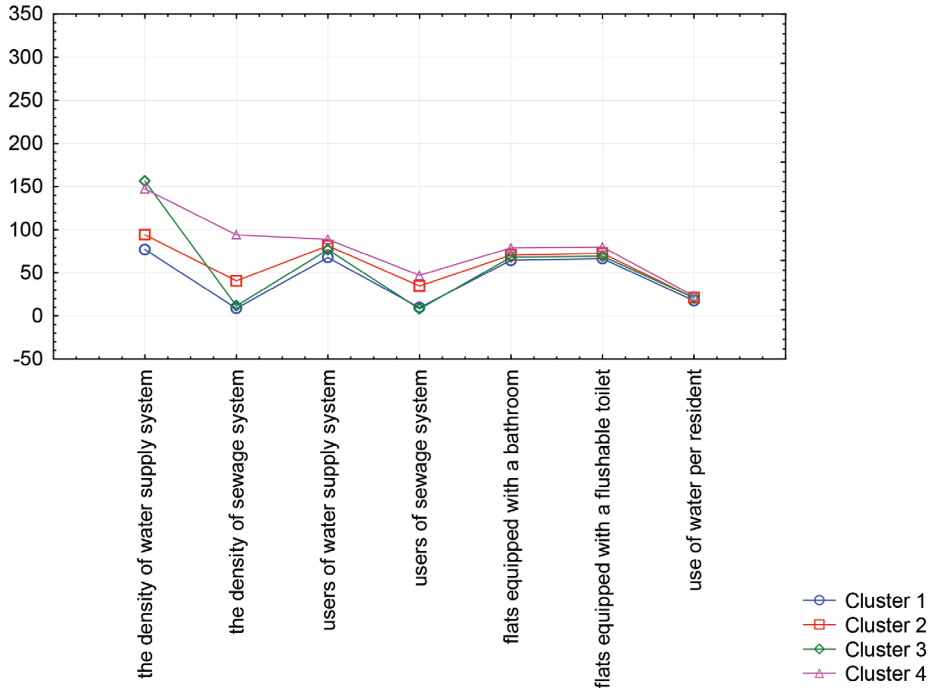

Figure 5. Mean values of each cluster with respect to the examined indicators of the technical infrastructure and the standard of living in the Świętokrzyskie voivodship.

It should be emphasized that the carried out analyses relate to the mean values of the indicators calculated on the basis of the data from the years 2008-2003. In order to study changes taking place in the assumed study period, an analysis of the dynamics of changes in the indicators was conducted. The methodology of this analysis was described in the previous chapter. For the purposes of this study the average rate of change of specified indicators with regards to the voivodships was calculated.

Figure 7 shows the average rate of change of the specified indicators of the technical infrastructure development and of the standard of living. In the Malopolskie voivodship it was found that none of the distinguished indicators stood out from the rest. The values of all the indicators examined had a similar average rate of change. In the Podkarpackie voivodship particularly fast pace of change was characterized by the indicator assessing the number of people using the water supply system. Compared to the average rate of increase in the density

of the water supply system, it is more than three times higher, which proves the rational development of the infrastructure component. An inverse relationship exists for the sewage system. The average rate of increase in the density of the system is twice as higher than the average rate of increase in the percentage of residents using the system. In the Podkarpackie voivodship a clear relationship between the dynamics of the percentage of population with access to water supply and water consumption per capita was noted.

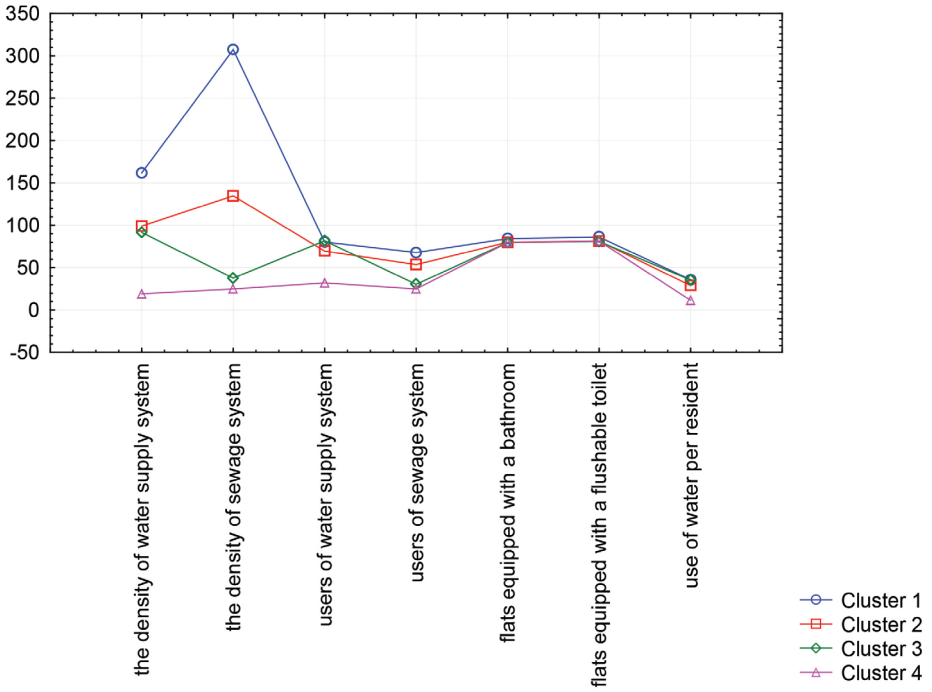

Figure 6. Mean values of each cluster with respect to the examined indicators of the technical infrastructure and the standard of living in the Podkarpackie voivodship.

In the Świętokrzyskie voivoship the average rate of development of the sewage system is in line with the average rate of increase in the population using the sewage system which proves the well-thought-out process of investment in this area.

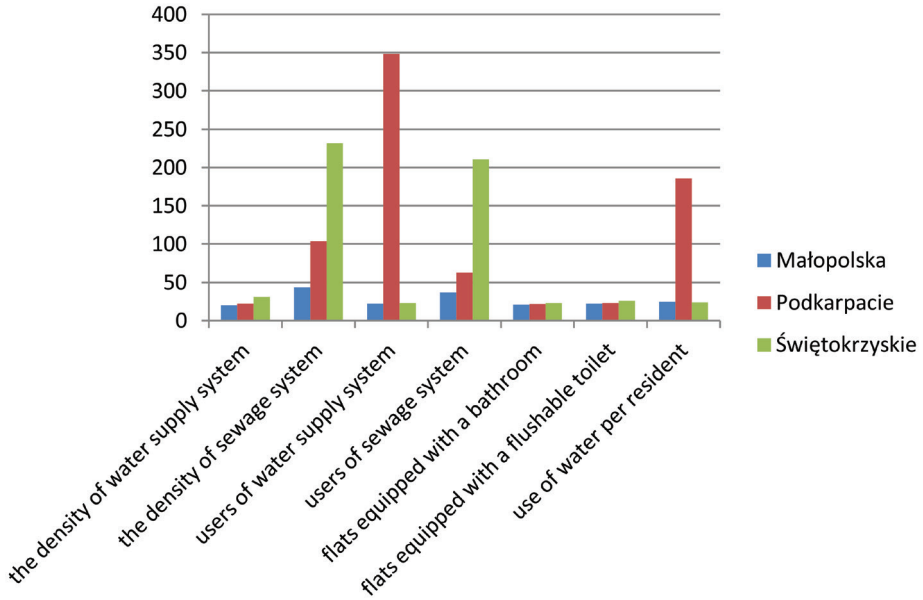

Figure 7. The values of average rate of change of the technical infrastructure development indicators and of the standard of living indicators in the surveyed voivodships

CONCLUSIONS

The applied cluster analysis allowed to isolate in each of the three regions analysed, 4 homogeneous, in view of the level of development of technical infrastructure and in view of the standard of living, groups of communities.

The conducted analysis showed significant differences in the level of infrastructure in the surveyed voivodships. This diversity is particularly evident in the case of the density of the sewage system and the density of the water supply system.

The lack of consistency in the level of the dynamics of the development of infrastructure with the dynamics of the percentage of residents using the equipment was noted. In particular, it refers to the Podkarpackie and Świętokrzyskie Voivodships which, in comparison to the Malopolskie Voivodship, have less developed water supply and sewerage infrastructure.

A positive phenomenon is that the development of the sewage system in all three voivodships has a higher average rate than the average rate of the development of the water supply system. This is particularly important due to the significant underdevelopment of the sewage system in relation to the water supply

system. In the analysed voivodships there were no significant differences in the indicator values assumed as the ones describing the standard of living.

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