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WASTE MANAGEMENT IN POLAND (2012–2013) – SPATIAL ANALYSIS

Karol Kukuła✉

Uniwersytet Rolniczy im. Hugona Kołłątaja w Krakowie

Abstract. The condition of the waste management development is a complex phenomenon described by eight diagnostic variables. The purpose of the paper is to indicate regional discrepancies in the scope of shaping of the phenomenon in 2012 and 2013. To achieve the purpose, the multivariate analysis was applied, with a particular focus on the zero unitarization method. As a result of application of the aforementioned methods, the ranking of voivodeships with respect to the level of their waste management development was obtained. Further, the voivodeships were divided into four groups: at a very high, high, moderate, and low level of the waste management development. The level of the waste management development is not evenly distributed between given voivodeships. There are significant discrepancies within the investigated area between the voivodeships leading in the ranking (Mazowieckie), and the last voivodeship in the fourth group (Świętokrzyskie) – [$I(Q_i) \cong 52.5$ in 2013].

Key words: waste, voivodeship, diagnostic variable, object, ranking

INTRODUCTION

Waste management is a significant element of bioeconomy. Significant waste-related tasks lying ahead of the humanity include waste collection, separation, conversion of waste to energy and heat, or resources for further processing, and waste treatment. Societies world-wide face challenges related, on the one hand, to the onerousness and harmfulness of excessive waste supplies and the abilities to process waste into goods for people, on the other.

The paper attempts to evaluate the level of the waste management development in given voivodeships in Poland. The research was carried out in two subsequent years: 2012 and 2013. It allows conducting the comparative analysis of the level of changes in 2013 with respect to the previous year. The evaluation of the level of the waste management development requires taking several determinants into consideration. In other words, the category "condition of the waste management development" is a complex one (Kukuła, 2000) in contrast to simple phenomena described with one variable. The following task was to determine the list of variables characterizing the level of the waste management development in Poland. The final result of the research is the ranking of voivodeships (objects) with respect to the value of a synthetic variable, i.e. the condition of the waste management development. In the next step, all objects were divided into four groups: at a very high, high, moderate, and low level of development of the investigated phenomena. With respect to the fact that both 2012 and 2013 voivodeship rankings were known, spatial changes were evaluated in the scope of the waste management development which occurred at the investigated period of time.

Reuse of waste translates into measurable economic benefits. It creates opportunities for economic development of regions by management of agricultural and non-agricultural post-production waste resulting in new jobs for people (see Skorwider-Namiotko, 2015).

✉prof. dr hab. Karol Kukuła, Katedra Statystyki i Ekonometrii, Wydział Rolniczo-Ekonomiczny, Uniwersytet Rolniczy w Krakowie, al. Mickiewicza 21, 31-120 Kraków, Poland, e-mail:ksm@ur.krakow.pl

The subject to the present research is the level of the waste management development in Poland in 2012 and 2013, a complex phenomenon described by several variables. The collected data on diagnostic variables characterizing the level of a complex phenomenon create a matrix:

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ x_{r1} & x_{r2} & \cdots & x_{rn} \end{bmatrix}, \quad \begin{pmatrix} i = 1,...,r \\ j = 1,...,n \end{pmatrix}, \qquad (1)$$

where r is the number of objects (voivodeships in this case), and n in the number of diagnostic variables. Therefore, x_{ij} is the value of a variable X_j in an ith object. Data on the selected diagnostic variables were taken from the following GUS annual sets (GUS, 2013; 2014).

RESEARCH METHOD

The selection of diagnostic features is a difficult and extremely important task affecting final results. When creating a ranking of voivodeships with respect to the level of a complex phenomenon, i.e. the condition of the waste management development, one applied two criteria: merit and statistical ones. The statistical criterion is an adequate level of variation of the feature previously qualified due to the merit criterion. To specify the variation level one applied a simple measuring tool, i.e. the quotient of extreme values of each variable (X_1, …, X_n):

$$I(X_j) = \frac{\max\limits_i x_{ij}}{\min\limits_i x_{ij}} \qquad (2)$$

Moreover, it is assumed that a feature fully corresponding to the merit criteria has to fulfil the following condition:

$$I(X_j) > 2 \qquad (3)$$

If a feature X_j takes fixed values, then $I(X_j) = 1$. The increase in the measuring tool means growing discrepancies (differences) between the best and the worst objects in relation to a given diagnostic variable. The measuring tool (2) constitutes sufficient criterion to determine an adequate level of variation of a feature qualified to the set of diagnostic variables for the major purpose of the present research, i.e. preparation of the ranking with respect to the level of the investigated complex phenomenon.

The multivariate comparative analysis covered the division of diagnostic features into stimulants and destimulants, introduced for the first time in the Polish literature of the subject by Z. Hellwig (1968). Constructing of synthetic variables should be preceded by transformation of diagnostic features, the so-called normalization. This process transforms various values of features of diagnostic values in their original shape into comparable ranges and reduces their denomination. The normalization method applied in the research to transform a feature X_j into a variable Z_j is called the zero unitarization method, described in details in (Kukuła, 2000). The diagnostic variables applied in the present research are stimulants, i.e. such variables whose increase reflects the increase in the evaluation of a complex phenomenon. Therefore, the formula applied to transform a feature X_j into a variable Z_j is the following:

$$z_{ij} = \frac{x_{ij} - \min\limits_i x_{ij}}{\max\limits_i x_{ij} - \min\limits_i x_{ij}} \qquad (4)$$

Values of the normalized diagnostic features – z_{ij} fulfil the following relation:

$$z_{ij} \in [0,1] \qquad (5)$$

Relations between extreme values of the features in their original shape and the transformed features are expressed in the following way:

$$z_{ij} = 0 \Leftrightarrow x_{ij} = \min_i x_{ij} \qquad (6)$$

and $z_{ij} = 1 \Leftrightarrow x_{ij} = \max\limits_i x_{ij}$, (when X_j is a stimulant) (7)

Values z_{ij} form a linear transformation of the diagnostic variables-stimulants x_{ij} in their original shape. Normalized values of the diagnostic features with the formula (4) can be presented in the form of a matrix:

$$Z = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1n} \\ z_{21} & z_{22} & \cdots & z_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ z_{r1} & z_{r2} & \cdots & z_{rn} \end{bmatrix}, \quad \begin{pmatrix} i = 1,...,r \\ j = 1,...,n \end{pmatrix}. \qquad (8)$$

The matrix (8) constitutes the basis of aggregation of the normalized features, and at the same time, gives a synthetic variable Q_i characterizing the level of a complex phenomenon in every object r:

$$Q_i = \frac{1}{n}\sum_{j=1}^{n} z_{ij} \qquad (9)$$

Synthetic variables obtained by means of the formula (9) take the values from the range [0, 1]. One should also add that:

$$Q_i = 1 \Leftrightarrow z_{i1} = z_{i2} = ... = z_{in} = 1 \quad (10)$$

and

$$Q_i = 0 \Leftrightarrow z_{i1} = z_{i2} = ... = z_{in} = 0 \quad (11)$$

Such extremes are rarely encountered in empirical studies on complex phenomena. Therefore, all investigated objects are characterized by the vector:

$$Q = \begin{bmatrix} Q_1 \\ Q_2 \\ \vdots \\ Q_r \end{bmatrix}, \quad (12)$$

which allows constructing a ranking of objects with respect to the level of development of the investigated phenomenon. A ranking means an ordered set of objects where objects of the highest values of a feature Q_i take first positions, and an object with the lowest value of a synthetic variable Q_i takes the last position.

Another step in the research is to divide objects into a given number groups. Due to the number of objects subject to the research (16 voivodeships) it seemed reasonable to distinguish three groups by means of the following algorithm (Kukuła, 2014):

a) calculate a range for a synthetic variable:

$$R(Q_i) = \max_i Q_i - \min_i Q_i \quad (13)$$

b) determine a value of a division parameter – k according to the formula:

$$k = \frac{1}{3} R(Q_i) \quad (14)$$

c) divide objects into groups in the following way:

– group I at a high level of development of the investigated phenomenon

$$Q_i \in [\max_i Q_i - k, \max_i Q_i] \quad (15)$$

– group II at a moderate level of development of the investigated phenomenon

$$Q_i \in [\max_i Q_i - 2k, \max_i Q_i - k) \quad (15)$$

– group III at a low level of development of the investigated phenomenon

$$Q_i \in [\max_i Q_i - 3k, \max_i Q_i - 2k). \quad (15)$$

If more than one ranking appears in studies (for example, in the present research there are two rankings of the same phenomenon for two different periods of time ($t = 0$ and $t = 1$)), the following formula can be applied for the comparison of discrepancies between both rankings U_0 and U_1 (Kukuła, 1986):

$$m_{01} = \frac{2\sum_{i=1}^{r} |d_{ij}|}{r^2 - z}, \quad \left(\begin{matrix} i = 1,...,r \\ j = 1,...,n \end{matrix} \right), \quad (16)$$

where

$$d_{ij} = c_{i0} - c_{i1} \quad (17)$$

and

$$z = \begin{cases} 0 & \text{if } r \in P \\ 1 & \text{if } r \notin P \end{cases}, \quad (18)$$

where:

c_{i0} – position of an ith object in the ranking for the period $t = 0$

c_{i1} – position of an ith object in the ranking for the period $t = 1$

P – set of even natural numbers.

The measuring tool m_{01} takes values from the range [0, 1]. The value of the measuring tool equal to 0 refers to the situation when the ranking for $t = 1$ is identical as the ranking for $t = 0$. And the other way around, $m_{01} = 1$ means maximum diversity between both rankings. Lets consider two order sets: U_0 = [B, A, D, C, F, G, E] and U_1 = [E, G, F, C, D, A, B]. In such situation, the measuring tool m_{01} is equal to 1. First letters of the alphabet denote objects with respect to positions they take in rankings U_1 and U_0.

SELECTED DIAGNOSTIC VARIABLES

With respect to the aforementioned selection criteria, one distinguished eight diagnostic variables characterizing the level of the waste management development in the subsequent years: 2012 and 2013. The variables are listed below:

X_1 – the volume of municipality waste collected and treated in kg per inhabitant

X_2 – the number of controlled waste landfill sites

X_3 – the number of landfill sites with degassing systems

X_4 – the number of landfill sites with degassing systems and energy recovery

X_5 – recycling of glass packaging waste in thou. tons

Table 1. Values of diagnostic variables describing the level of waste management in Poland in 2013
Tabela 1. Wartości zmiennych diagnostycznych opisujących stopień rozwoju gospodarki odpadami w Polsce w 2013 roku

Voivodeships Województwa	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Dolnośląskie	261,1	30	29	4	24 577	69 931	6 561	94
Kujawsko-Pomorskie	211,2	32	21	4	2 530	27 556	6 829	73
Lubelskie	140,3	56	40	1	0	2 673	161	45
Lubuskie	268,1	14	11	1	49	5 358	1 362	39
Łódzkie	199,1	23	22	4	0	1 178	1 417	75
Małopolskie	176,5	23	23	5	137 784	92 992	28 209	110
Mazowieckie	214,3	57	45	10	274 747	478 037	116 240	194
Opolskie	214,5	21	20	1	0	10 540	867	32
Podkarpackie	142,6	22	18	2	7 827	2 560	1 825	54
Podlaskie	195,0	15	11	1	0	44	351	18
Pomorskie	245,2	18	17	4	932	26 897	4 314	83
Śląskie	252,2	26	24	11	0	6 401	1 895	186
Świętokrzyskie	111,7	15	13	1	0	1 008	701	28
Warmińsko-Mazurskie	205,4	19	11	1	25	3 603	979	48
Wielkopolskie	236,0	43	41	4	14 070	15 439	3 015	133
Zachodniopomorskie	264,7	17	17	5	3 286	33 903	4 172	64
$I(X_j)$	2,40	4,07	4,09	11,00	10 989,88*	10 864,48	721,99	10,78
Polska Poland	212,9	431	363	59	465 827	778 120	178 898	1 275

*In the case of variable X_5 you shouldn't calculate value of $I(X_5)$ because dividing by 0 is impossible. Therefore you have to take minimum of the remaining values of this variable.
Source: GUS, 2014.
*W przypadku zmiennej X_5 nie można przy liczeniu $I(X_5)$ dzielić przez 0, wzięto zatem minimum z pozostałych wartości tej zmiennej.
Źródło: GUS, 2014.

X_6 – recycling of paper and cardboard packaging waste in thou. tons

X_7 – recycling of plastic packaging waste in thou. tons

X_8 – the volume of waste collected and separated in thou. tons.

Table 1 presents the data on the diagnostic variables collected in 2013 (X_1, X_2, …, X_8). Their normalized values are shown in Table 2. When analysing the values of the measuring tool $I(X_j)$ for all selected diagnostic variables, what draws particular attention is the large scale of variation of features X_5, X_6 and X_7 (see Table 1). All these features are related to recycling of packaging waste of glass, paper and cardboard, and plastics. Recycling is a type of recovery where waste is processed into products, materials, or substances for reuse. Therefore, recycling should be treated as a manifestation of innovation in economy. As far as recycling of the aforementioned waste is concerned, two voivodeships are evident leaders in this area in Poland: Mazowieckie and Małopolskie (Table 1). This is to some extent reflected in the rankings constructed both for 2013 and 2012 (Table 3 and 4).

Table 2. Values of diagnostic variables describing the level of waste management in Poland in 2013
Tabela 2. Wartości unormowanych zmiennych diagnostycznych opisujących stopień rozwoju gospodarki odpadami w Polsce w 2013 roku

Voivodeships Województwa	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7	Z_8	Σz_{ij}	Q_i
Dolnośląskie	0.955	0.372	0.529	0.300	0.089	0.146	0.055	0.432	2.878	0.3598
Kujawsko-Pomorskie	0.636	0.419	0.294	0.300	0.009	0.058	0.057	0.313	2.086	0.2607
Lubelskie	0.183	0.977	0.853	0	0	0.006	0	0.153	2.172	0.2715
Lubuskie	1.000	0	0	0	0.001	0.011	0.010	0.119	1.141	0.1426
Łódzkie	0.559	0.209	0.324	0.300	0	0.002	0.011	0.324	1.729	0.2161
Małopolskie	0.414	0.209	0.353	0.400	0.103	0.194	0.242	0.523	2.438	0.3048
Mazowieckie	0.656	1.000	1.000	0.900	1.000	1.000	1.000	1.000	7.556	0.9445
Opolskie	0.657	0.163	0.265	0	0	0.022	0.006	0.080	1.193	0.1491
Podkarpackie	0.198	0.186	0.206	0.100	0.028	0.005	0.014	0.205	0.942	0.1178
Podlaskie	0.533	0.023	0	0	0	0	0.002	0	0.558	0.0698
Pomorskie	0.854	0.093	0.176	0.300	0.003	0.056	0.036	0.369	1.887	0.2359
Śląskie	0.898	0.279	0.382	1.000	0	0.013	0.015	0.955	3.542	0.4428
Świętokrzyskie	0	0.023	0.059	0	0	0.002	0.005	0.057	0.146	0.0183
Warmińsko-Mazurskie	0.599	0.116	0	0	0.001	0.007	0.007	0.170	0.900	0.1125
Wielkopolskie	0.795	0.674	0.882	0.300	0.051	0.032	0.025	0.653	3.412	0.4265
Zachodniopomorskie	0.978	0.070	0.176	0.400	0.012	0.071	0.035	0.261	2.003	0.2504

Source: own elaboration on the basis of data from Table 1.
Źródło: obliczenia własne na podstawie danych z tabeli 1.

EMPIRICAL RESEARCH RESULTS IN 2013

By means of the available data presented in Table 2 and the formula (9) the ranking of voivodeships was constructed concerning the level of the waste management development in Poland in 2013. The ranking is shown in Table 3. The unquestionable leader of the ranking with an edge over other regions is Mazowieckie; its synthetic variable (0.9445) is twice as high as the synthetic variable for śląskie (0.4428) which was on the second position in the ranking. It should be noted that the ranking demonstrated significant discrepancy in the value of a synthetic variable $I(Q_i) \cong 52.5$. It means that, as far as the waste management development is concerned, mazowieckie outrivaled Świętokrzyskie, the last voivodeship in the ranking, over 52 times.

Applying the procedure determined in the formulas (13), (14), and (15), the objects from the 2013 ranking were divided into 3 groups, as previously assumed. Due to the outlier (Mazowieckie) an empty group between this voivodeship and the rest of the objects was obtained. Therefore, the division procedure was repeated with exclusion of Mazowieckie. This voivodeship constitutes a separate, individual group at a very high level of development of the investigated phenomenon. Another group II at a high level of the waste management development covers four voivodeships (in the exact order: Śląskie, Wielkopolskie, Dolnośląskie, and Małopolskie). Group III at a moderate level of development of the phenomenon subject to the research includes fives voivodeships, in the following order: Lubelskie, Kujawsko-Pomorskie, Zachodniopomorskie, Pomorskie, and

Table 3. Ranking of voivodeships according to the level of waste management in 2013
Tabela 3. Ranking województw według stopnia rozwoju gospodarki odpadami w 2013 roku

Place in ranking Pozycja w rankingu	Voivodeships Województwa	Q_{i1}	Groups (with number of voivodeships) Grupy (z liczbą województw)
1	Mazowieckie	0.945	I (1)
2	Śląskie	0.443	II (4)
3	Wielkopolskie	0.427	
4	Dolnośląskie	0.360	
5	Małopolskie	0.305	
6	Lubelskie	0.272	III (5)
7	Kujawsko-Pomorskie	0.261	
8	Zachodniopomorskie	0.250	
9	Pomorskie	0.236	
10	Łódzkie	0.216	
11	Opolskie	0.149	IV (6)
12	Lubuskie	0.143	
13	Podkarpackie	0.118	
14	Warmińsko-Mazurskie	0.113	
15	Podlaskie	0.070	
16	Świętokrzyskie	0.018	
$I(Q_{i1})$			52.5

Source: own elaboration on the basis of data from Table 2.
Źródło: obliczenia własne na podstawie danych z tabeli 2.

Łódzkie. The last group IV consists of 6 voivodeships: Opolskie, Lubuskie, Podkarpackie, Warmińsko-Mazurskie, Podlaskie, and Świętokrzyskie. Figure 1 presents the spatial distribution of the groups.

EMPIRICAL RESEARCH RESULTS IN 2012

By constructing the second ranking of voivodeships with respect to the same complex phenomenon in 2012 one aimed at obtaining a basis for comparison of the results for 2013. The paper used the data from the earlier paper by (Kukuła, 2014) covering the ranking of voivodeships with respect to the waste management development in Poland in 2012. Therefore, to obtain a specific point of reference, the ranking of voivodeships (Table 4) and their spatial distribution were presented in Figure 2. Only Mazowieckie belongs to group I at the highest level of development of the phenomenon subject to the research. The last group IV includes the same 6 voivodeships as group IV in the ranking for 2013, with only small, intra-group dislocations. It should be highlighted that this group is the largest group in both rankings for 2012 and 2013.

COMPARISON BETWEEN RANKINGS 2013/2012

The result of comparing both rankings on the condition of the waste management development in 2012 and 2013 determines the level of changes in the orders for the investigated area. To specify the level of these changes in a quantitative way, one should apply the

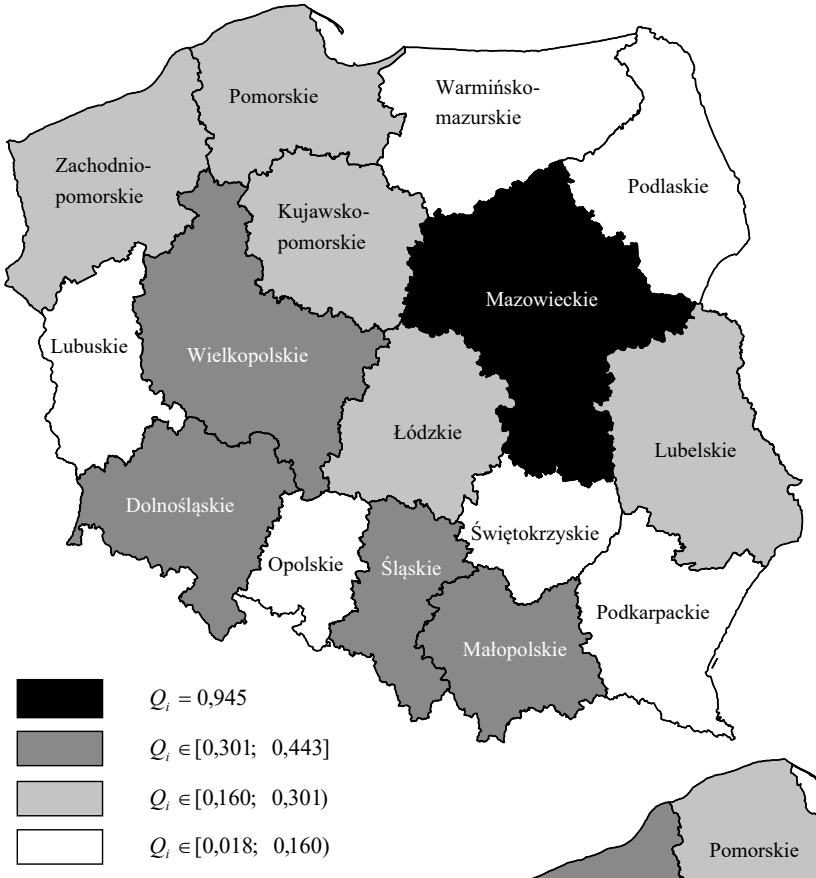

Fig. 1. Voivodeships according to the level of waste management in 2013
Source: own elaboration on the basis of data in Table 3.
Rys. 1. Województwa wg stopnia rozwoju gospodarki odpadami w 2013 roku
Źródło: opracowanie własne na podstawie danych z tabeli 3.

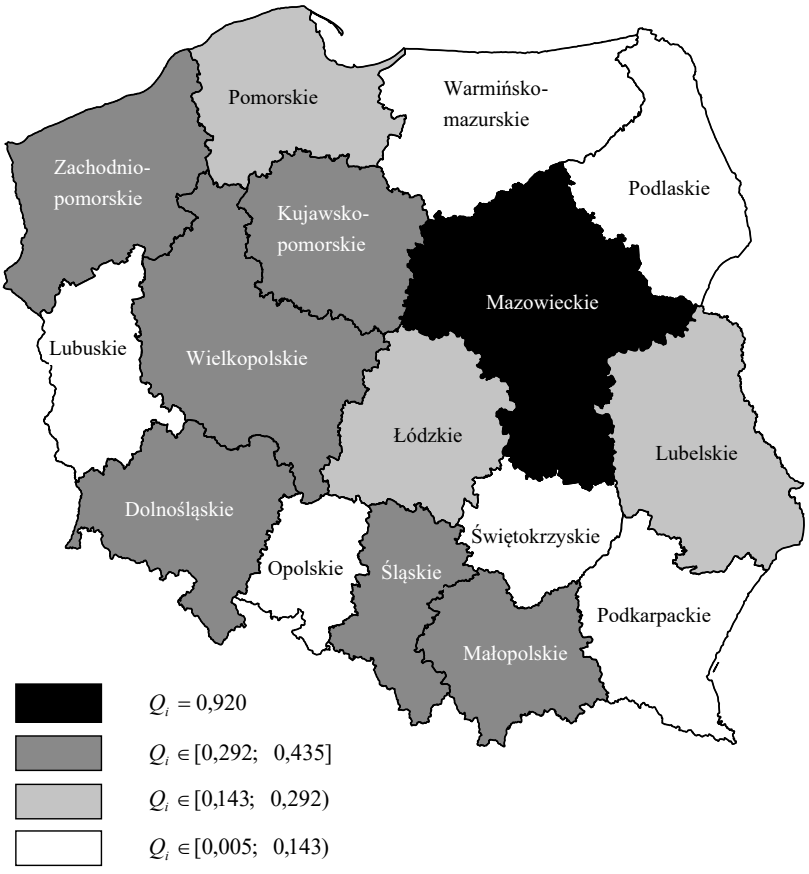

Fig. 2. Voivodeships according to the level of waste management in 2012
Source: Kukuła, 2014.
Ryc. 2. Województwa wg stopnia rozwoju gospodarki odpadami w 2012 roku
Źródło: Kukuła, 2014.

Table 4. Ranking of voivodeships according to the level of waste management in 2012
Tabela 4. Ranking województw wg stopnia rozwoju gospodarki odpadami w 2012 roku

Place in ranking Pozycja w rankingu	Voivodeships Województwa	Q_{i0}	Groups (with number of voivodeships) Grupy (z liczbą województw)
1	Mazowieckie	0.920	I (1)
2	Wielkopolskie	0.435	II (6)
3	Śląskie	0.421	
4	Dolnośląskie	0.385	
5	Małopolskie	0.376	
6	Kujawsko-Pomorskie	0.314	
7	Zachodniopomorskie	0.312	
8	Pomorskie	0.275	III (3)
9	Lubelskie	0.243	
10	Łódzkie	0.207	
11	Opolskie	0.147	IV (6)
12	Lubuskie	0.136	
13	Podkarpackie	0.113	
14	Podlaskie	0.107	
15	Warmińsko-Mazurskie	0.098	
16	Świętokrzyskie	0.005	
$I(Q_{i0})$			184.0

Source: Kukuła, 2014.
Źródło: Kukuła, 2014.

measurement (16). The measurement takes values from the range [0, 1], and is distributed in a linear way for all changes between positions of the objects in both periods of time subject to comparison. The variation range for the measurement allows interpreting by means of a percentage scale. To determine the value of the inter-ranking comparison measurement, one prepared Table 5. After adequate substitutions in formulas (16) and (17), the following formula was obtained:

$$m_{o1} = \frac{2 \cdot 10}{16^2 - 0} = \frac{20}{256} \cong 0.078 \qquad (19)$$

The result means slight changes in the investigated rankings in the compared periods of time. The level of discrepancy for both orders can be determined as the change at the level of around 8%. In other words, voivodeships positioned at top ranks in the 2012 ranking took the same high positions in 2013 with slight changes, and all voivodeships in the last group of the lowest waste management development level stayed in the same group in 2013. In both rankings mazowieckie was the leader clearly outrivaling the voivodeship on the second place. When analysing the value of a synthetic variable, it is visible that the voivodeship increases its distance to the second object in the ranking. The same situation is observed for the last position. Świętokrzyskie is the last one in both rankings. Taking into account also the positive sides of the evaluation, one should add that the voivodeship slightly improved its value of the synthetic variable from 0.005 to 0.018. However, it was not sufficient enough to go up in the ranking.

Table 5. Positions of voivodeships in rankings in 2012 and 2013
Tabela 5. Pozycje województw w rankingach z lat 2012 i 2013

Current number Lp.	Voivodeships Województwa	Ranking position Pozycja w rankingu		d_i	$\|d_i\|$
		q_{i0}	q_{i1}		
1	Dolnośląskie	4	4	0	0
2	Kujawsko-Pomorskie	6	7	–1	1
3	Lubelskie	9	6	3	3
4	Lubuskie	12	12	0	0
5	Łódzkie	10	10	0	0
6	Małopolskie	5	5	0	0
7	Mazowieckie	1	1	0	0
8	Opolskie	11	11	0	0
9	Podkarpackie	13	13	0	0
10	Podlaskie	14	15	–1	1
11	Pomorskie	8	9	–1	1
12	Śląskie	3	2	1	1
13	Świętokrzyskie	16	16	0	0
14	Warmińsko-Mazurskie	15	14	1	1
15	Wielkopolskie	2	3	–1	1
16	Zachodniopomorskie	7	8	–1	1
Σ		–	–	0	10

Source: own elaboration on the basis of data in Tables 3 and 4.
Źródło: opracowanie własne na podstawie tabel 3 i 4.

CONCLUSION

1. The application of the multivariate statistical analysis is a useful tool in regional studies.

2. Significant regional discrepancies with respect to the level of the waste management development for both of the investigated periods of time were observed.

3. The voivodeship at the highest level of the waste management development in both periods of time subject to comparison was Mazowieckie. Its advantage in the synthetic variable value over other voivodeships is very clear. Similarly, Świętokrzyskie demonstrates the lowest level of the waste management development, visibly outrivaled by other objects in group IV.

4. Group IV stays the same in both rankings and includes the largest number of objects – six voivodeships.

5. Taking into consideration the waste recycling processes, one noticed the clear advantage of two objects: Mazowieckie and Małopolskie over the other voivodeships.

6. In the investigated period of time, slight, even minute, changes in the ordinal distribution of voivodeships were observed ($m_{01} \cong 0.078$). The complete stabilization of the composition of group IV (the weakest objects) can trigger some anxieties. It means that voivodeships at a low level of the waste management development do not undertake effective efforts to leave the group.

7. Only five objects represent a very high or high level of the waste management development in 2013;

they are as follows: (in the exact order) Mazowieckie, Śląskie, Wielkopolskie, Dolnośląskie, and Małopolskie.

8. Waste management is connected with numerous fields such as: bio-economy, environmental protection, environmental friendly activities, and acquisition of renewable energy.

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GOSPODARKA ODPADAMI W POLSCE (2012–2013) – STUDIUM PRZESTRZENNE

Streszczenie. Stan rozwoju gospodarki odpadami to złożone zjawisko, opisywane przez osiem zmiennych diagnostycznych. Celem artykułu jest wykazanie zróżnicowań regionalnych w zakresie kształtowania się tego zjawiska w latach 2012 i 2013. Dla realizacji tego celu wykorzystano metody wielowymiarowej analizy statystycznej, ze szczególnym uwzględnieniem metody unitaryzacji zerowanej. W wyniku zastosowania opisanych metod otrzymano ranking województw ze względu na poziom rozwoju gospodarki odpadami. W dalszej kolejności dokonano podziału województw na cztery grupy: bardzo wysokiego, wysokiego, przeciętnego i niskiego poziomu omawianego zjawiska. Poziom rozwoju gospodarki odpadami nie rozkłada się równomiernie na poszczególne województwa. Istnieją ogromne różnice w tym zakresie między województwem przodującym w rankingu (mazowieckie) a województwem ostatnim z czwartej grupy (świętokrzyskie): $I(Q_i) \cong 52{,}5$ w 2013 roku.

Słowa kluczowe: odpady, województwo, cechy diagnostyczne, obiekt, ranking

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