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Environmental Quality as a Decisive Variable in Shaping Regional Development Policy

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Abstract. The article examines the impact of environmental quality on shaping the development policy of Polish voivodeships. The main analytical tool used was the synthetic index of environmental quality, compiled by means of the Perkal method. It was constructed in order to organize Polish voivodeships in terms of environmental quality, which was determined in a comprehensive way on the basis of three thematic areas: advantages of the natural environment, the level of pollution (degradation) of the environment as well as active protective activities. The obtained values of synthetic measures were then compared to the level of economic growth of Polish regions. It was necessary in determining which voivodeships perceive the quality of the environment as the main factor enhancing their economic growth, and which treat it as a barrier to economic development.

Keywords: environmental quality, Perkal method, economic growth, regional development policy

1. Introduction

In shaping the contemporary socio-economic development, a growing importance is attributed to environmental quality. The central place of high dynamics of economic growth was taken by the quality of inhabitants' lives. It is influenced, except for living and working conditions related mostly to income and the possibility to cover expenditures of maintaining households, by living standards and in particular health level, which depends, among others, on the degree of air pollution, noise level, water quality or the presence of green areas and biodiversity.

Even the representatives of the classical theory of economics wondered whether natural resources and population growth are barriers or determinants of economic growth (Smith 1776, Mill 1848, Malthus 1798, Say 1803, Schumpeter 1912, after: Bartkowiak 2013, pp. 83–102). The significance of the environment to the economy was firstly highlighted by A. Smith (Smith

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1776 after Murphy 2009). In his views, he revealed moderate geographical determinism and proved that favourable climatic conditions significantly affect more dynamic economic growth. In turn, D. Ricardo noticed that excessive use of the natural environment is a barrier to economic growth (Ricardo 1919).[1] In his models of growth he attributed a crucial role to the law of diminishing soil productivity, which lead to constantly decreasing revenues in agricultural sector as well as in the mining industry. The views of the economics classics on the role of the environment in economic growth were proper in the period of their active academic work, before the revolution in population growth and the shaping of the market economy. They did not include, however, technical progress which, in accordance with the alternative law of growing revenues, influences a constant increase in productivity of factors of production. Modern views on the environmental issues were expounded by other representatives of the classical school of economics, such as: J.St. Mill and J.B. Say. It was J.St. Mill who, for the first time, abandoned the traditional understanding of the environment, by emphasizing its importance for the quality of human life.[2] The greatest interest in the issues natural resources exhaustion, environmental pollution as well as its protection, developed no sooner than at the turn of the 1960s and 1970s of the twentieth century.[3] The exogenous factors (historical – in economics) which had a great influence on the growth of interest in this field were internationalization and globalization of the ecological crisis. The endogenous (logical) factor, on the other hand, were the changes in economics aiming towards better examination and analysis of phenomena arising at the point where economy meets natural environment. It was reflected in the neoclassical theory of ecologically sustainable growth, whose main provision was the economic growth in which the increase in gross domestic product, consumption and capital do not result in changes in the environmental quality.[4] The starting point was a social well-being as a variable dependent on material production and quality of the environment. According to the neoclassical theory of ecologically sustainable economic growth, the issues of environmental protection and pollution are therefore barriers to economic growth. They require, on the one hand, incurring considerable expenses on preserving the socially desired quality of the environment for the future generations. On the other hand, however, they require reducing the pace of economic product creation by resigning from various kinds of business operations, including specific product investments. In reality, the increase in capital spending on environmental protection is considerably influenced by technological progress resulting in, for instance, a decrease in energy intensity of gross domestic product or the growth in effectiveness of

technical methods of environmental protection. In the field of environmental protection, some regularities can be observed that are related to the law of diminishing productivity and the social tendency that is growing proportionally to the improvement in welfare, towards spending the increased part of its financial resources on improvements in environmental quality. The law of diminishing productivity states that in order to achieve higher quality of the environment, it is required to bear higher than proportional costs on its protection and restoration. In short and medium periods in particular, it leads to weakening of the dynamics of social welfare growth. According to the assumptions of the neoclassical theory of externalities, if the costs of reducing emissions are relatively higher than polluting the environment, the improvement of environmental quality can even be accompanied by deterioration in social welfare. However, the protective investments may also consist of increasing the capacity of the environment to assimilate waste inputs and contamination and in this way lead to ecologically sustainable economic growth. An in-depth analysis of these issues leads to a conclusion that pollution of the environment is a barrier to economic growth when it causes deterioration in social welfare. Empirical research shows that societies with relatively higher level of material welfare tend to increase spending on protective investments, care about the quality of the environment, and hence counteract ecologically negative effects of economic development.

These issues were reflected in numerous planning documents in gminas, regions, countries and the European Union and included provisions indicating the role of the environment in the development of economies worldwide. At present, the European Union development strategies for a country, region or gmina are based on the provisions of the European Commission Communication entitled: 'Europe 2020 – Strategy for Smart, Sustainable and Inclusive Growth'. It includes, among others, sustainable development, which consists of providing more effective support for the economy. This kind of economy should use resources and ought to be more environmentally-friendly and thus more competitive.

The aim of this article is to create a synthetic index of environmental quality and indicate the role of the natural environment in shaping the development policy of Polish regions. While creating a comprehensive definition of environmental quality, three thematic fields should be taken into account: advantages of the natural environment, the level of pollution (degradation) of the environment as well as active protective activities. The analysis of detailed indexes of the development of Polish regions in environmental and spatial dimension indicates significant differences in this field between voivodeships (Perło 2013). There is no voivodeship in Poland which

is the leader in all thematic areas in environmental and spatial dimension. For this reason, in order to indicate the position of Polish voivodeships in terms of the quality of the natural environment and at the same time analyze main problems related to its regional degradation and the impact of the environment on shaping the regional policy, a synthetic index aggregating the most important observable variables in environmental and spatial dimension should be created. In its construction the Perkal method was applied (Perkal 1953).[5]

2. Methodological foundations of the synthetic index structure

The procedure of creating the taxonomic synthetic indicator, which is the Perkal measure, consists of the following stages (Kolenda 2006, pp. 133–137; Panek 2009, pp. 64–75):

1. Determining the set of diagnostic variables (measures): $\{X_1, X_2, \ldots, X_n\}$.
2. Selecting diagnostic measures which form an aggregate of synthetic measure meeting the already established criteria.
3. Transforming diagnostic variables: stimulation and standardization of variables.
4. Determining the synthetic indicator and the ranking of multi-feature objects.

All the diagnostic variables selected to the analysis must meet the following criteria: universality, comparability, variability and validity (Hellwig, Siedlecka, Siedlecki 1997, pp. 24–28). Universality means that diagnostic indicators have commonly recognized importance and meaning. Comparability requires presenting variables in the form of intensity indexes. Variability and validity are statistical criteria. The first one is most often examined on the basis of a classical coefficient of variation (V_s), in order to determine whether the variables are similar regarding information about objects. The second one is examined on the basis of classical coefficient of asymmetry (A_s). Important variables are proper variables. They have layout similar to normal, or at least to symmetric – then they are called standard variables. In practice, variables with marked right side asymmetry are also useful. These are variables of increased selectivity, useful in case of searching for the best object in a particular set (Hellwig, Siedlecka, Siedlecki 1997, pp. 24–28).

Detailed indexes may variously affect the general assessment of the researched object situation in the analysed research area. Most often three categories of variables are distinguished: stimulants, destimulants and nom-

inants. The concept of stimulants and destimulants was introduced to comparative studies by Z. Hellwig (Hellwig 1968), and the idea of nominants by T. Borys (Borys 1984). A stimulant is such a characteristic whose high values are beneficial from the point of view of a non-observable variable. It means that the higher the stimulant's value, the higher the level of the examined phenomenon. On the other hand, destimulant's low values are beneficial for a non-observable variable, so consequently the higher the value of a destimulant, the lower the level of the analysed phenomenon. A nominant, however, is characterized by specific 'normal' level, deviations from which are considered to be a negative phenomenon from the point of view of the examined non-observable variable. The decision on whether a given variable is a stimulant, destimulant, or nominant depends on substantive circumstances and theoretical knowledge about a variable, rather than on statistical data. However, the verification of the adopted nature of variables can be performed *ex post*, by checking the correlation of particular variables with a synthetic variable. Stimulants should be positively correlated, destimulants – negatively and nominants should have no important correlation with a non-measurable variable.[6]

The necessary condition for applying the Perkal method is a positive correlation between diagnostic variables (Perkal 1953 after Ilnicki 2009, p. 20). It can be achieved by standardizing the nature of variables, which consists of their transformation into stimulants. For the purpose of this article the following changes were introduce:[7]

– destimulants were transformed into stimulants (Walesiak 1990, p. 41):

$$x'_{ij} = 2\bar{x}_j - x_{ij} \tag{1}$$

where:

$\bar{x}_j$ – arithmetic mean of variable X_j-destimulants.

– nominants were transformed into a stimulant:[8]

$$f(x) = \begin{cases} 1 - \left(\frac{c_1 - x_i}{c_1 - a}\right)^{p_1} & \text{dla } x \in (-\infty, c_1) \\ 1 & \text{dla } x \in \langle c_1, c_2 \rangle \\ 1 - \left(\frac{x_1 - c_2}{b - c_2}\right)^{p_2} & \text{dla } x \in (c_2, \infty) \end{cases} \tag{2}$$

where:

$f(x)$ – the value of the obtained stimulant,

c_1 and c_2 – parameters determining the range of the most desired values,

a and b – zeros of $f(x)$ function – parameter determining the range of the, so called, acceptable values of a nominant, $f(x) \geq 0$ for $x \in [a, b]$,

p_1, p_2 – parameters responsible for the type of $f(x)$ function, and:

p_1 – determines $f(x)$ for, $x_i \in (-\infty, c_1)$ for the left range of the nominant,

p_2 – determines $f(x)$ for, $x_i \in (c_2, +\infty)$ for the right range of the nominant.

In order to facilitate the comparability of characteristics with different sizes and various names, the process of standardization should be applied. Standardization enables the comparative analysis of a set with various features of different values and names. The literature describes different methods of features' normalization e.g., by standardization, quotient transformation, unitarity (Borys 1978, Walesiak 1988). The article standardizes the realization of j-variable (measure) on i-object on the basis of the following formula:

$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}, \tag{3}$$

in which:

x_{ij} – empirical value of j-variable on i-object,

$\bar{x}_j$ – arithmetic mean in distribution of X_j indicator ,

s_j – standard deviation in distribution of X_j indicator.

The last stage is to determine the synthetic indicator and the ranking of multi-feature objects. In the Perkal method, the values of an aggregated variable are determined as an arithmetic means of standardized (normalized) values of diagnostic variables, on the basis of the formula (see Perkal 1953):

$$W_i = \frac{1}{n} \sum_{j=1}^{n} z_{ij} \tag{4}$$

in which:

W_i – the value of the synthetic indicator of i-object,

z_{ij} – normalized realization value of j-variable on i-object,

n – the number of diagnostic variables.

The higher the value in the researched area a given object has, the higher values the Perkal measure (W_i) takes. It may constitute the basis for organizing the observation units and for drawing conclusions about objects under examination and it may also be the basis for further, more detailed, statistical analyses (Ilnicki 2009, pp. 19–22). Due to this, in the next stage there is a possibility of determining the degree of proportionality of the

development level of objects in relation to the analyzed variables (Namyślak 2013, pp. 25–30). It consists of determining the reminders (C_{ij}), namely the differences between standardized values of diagnostic variables and the value of synthetic variable according to the formula:

$$C_{ij} = z_{ij} - W_i, \tag{5}$$

The positive remainders inform about the higher development of the objects in relation to the examined variable, the negative – about a lower ones. This means that in the final result it is possible to determine which objects develop relatively proportionally, and which inversely proportionally, according to the analyzed variables.[9]

3. Synthetic index of environmental quality

For the purpose of comprehensive explanation of the researched area, environmental quality has been defined from the perspective of three thematic areas: advantages of the natural environment, the level of pollution (degradation) of the environment as well as active protective activities. The substantive selection of representative indicators was arbitrary (on the basis of logical conclusions and available statistical data) and determined by the purpose of the research. Synthetic indexes were created on the basis of cross-sectional data, concerning sixteen voivodeships in Poland in 2010 and in 2005.[10] Every analyzed detailed index of the environmental and spatial dimension was verified according to the examined statistical criteria, concerning the degree of diversity ($V_s > 10\%$) as well as the strength and direction of asymmetry ($A_s > 0$). Moreover, the analysis of correlation coefficients between variables was performed to verify whether the correlation between observable variables has appropriate direction and strength. On this basis, a set of twenty observable variables analyzed initially was reduced to twelve (see Perło 2013). The advantages of the natural environment are defined by three diagnostic variables (S_10, S_11 and S_12), the level of pollution (degradation) of the environment by six diagnostic variables (S_01, S_02, S_03, S_06, S_07, S_08), and active protective activities by three variables (S_4, S_5, S_9). The list of these variables is presented in table 1 and their statistical analysis in table 2.

Five out of the twelve observable variables were defined as stimulants (S_04, S_06, S_09, S_11, S_12), five – as destimulants (S_01, S_02, S_03, S_06, S_08), and two as nominants (S_07, S_10). Destimulants were transformed into stimulants on the basis of the formula (1), and nominants were

Table 1
Observable variables of the synthetic index of environmental quality (JS)

No.	Symbol	The importance of the regional index of environmental quality
1	S_01	Gas pollution in t/km^2
2	S_02	Dust pollution in t/km^2
3	S_03	Automotive industry pressure on the environment, counted as a relation of the ratio between the length of roads and the average congestion of traffic to the area of a voivodeship
4	S_04	Industrial and municipal sewage treated biologically, chemically and with increased removal of biogenic substances in % of sewage requiring treatment
5	S_05	The size of sewage treatment plants in population equivalents per capita
6	S_06	Water consumption for the needs of national economy and population as a percentage of operating resources of underground waters
7	S_07	Built-up and urbanized area as a percentage of a total area
8	S_08	Devastated and degraded grounds requiring reclamation as a percentage of a total area
9	S_09	The share of renewable energy in the overall electric energy production in %
10	S_10	The share of legally protected areas in the total area in %
11	S_11	The share of national parks in the legally protected areas in %
12	S_12	Some important protected animals in pcs./100 km^2

Source: Prepared by the author

Table 2
Basic parameters of the statistical analysis of observable variables in environmental and spatial dimension in 2010 and 2005

Parameter	Variable symbol											
	S_01	S_02	S_03	S_04	S_05	S_06	S_07	S_08	S_09	S_10	S_11	S_12
2010												
average	691	0.20	2	11	1.18	60	0.20	5	7	32	1.01	23
deviation	746	0.19	2	13	0.15	56	0.09	2	9	11	1.20	18
coefficient of variety	108	96	63	118	13	93	45	31	133	35	119	79
coefficient of asymmetry	2.13	3.33	2.03	0.44	0.78	2.18	0.42	2.72	1.69	1.03	1.80	1.70
2005												
average	683	0.35	2	8	1.12	63	0.21	5	3	33	1.01	15
deviation	722	0.32	1	11	0.18	52	0.09	1	6	12	1.20	16
coefficient of variety	106	91	59	129	16	84	43	29	232	37	118	110
coefficient of asymmetry	2.03	3.26	1.68	0.69	0.11	0.95	0,49	2.65	2.80	0.85	1.79	1.95

Source: Own calculations on the basis of observable variables of a synthetic index of environmental quality

Table 3
Ranking of Polish voivodeships in terms of synthetic index of environmental quality in 2010 (JS_10) and in 2005 (JS_05)

2010			Change in position	2005		
No.	Voivodeship	JS_10	2010/2005	No.	Voivodeship	JS_05
1	Podlaskie	0,950	without changes	1	Podlaskie	0,906
2	Warmińsko-Mazurskie	0,677	without changes	2	Warmińsko-Mazurskie	0.785
3	Kujawsko-Pomorskie	0.390	without changes	3	Kujawsko-Pomorskie	0.523
4	Lubuskie	0.345	without changes	4	Lubuskie	0.317
5	Pomorskie	0.321	without changes	5	Pomorskie	0.305
6	Podkarpackie	0.159	without changes	6	Podkarpackie	0.195
7	Łódzkie	0.069	without changes	7	Łódzkie	0.067
8	Zachodniopomorskie	−0,067	increase	8	Opolskie	0.021
9	Lubelskie	−0,160	increase	9	Zachodniopomorskie	−0,071
10	Wielkopolskie	−0,174	increase	10	Lubelskie	−0,188
11	Opolskie	−0,208	decrease	11	Wielkopolskie	−0,273
12	Małopolskie	−0,285	increase	12	Świętokrzyskie	−0,310
13	Dolnośląskie	−0,287	without changes	13	Dolnośląskie	−0,329
14	Świętokrzyskie	−0,352	decrease	14	Mazowieckie	−0,435
15	Mazowieckie	−0,375	decrease	15	Małopolskie	−0,507
16	Śląskie	−1,002	without changes	16	Śląskie	−1,005

Source: Prepared by the author on the basis of taxonomic analysis results

transformed into stimulants on the basis of the formula (2). Calculations were made with the use of 'Taxonomy' program designed by K. Kolenda. The synthetic measure values of the environmental quality of Polish regions in 2010 and in 2005, positions of voivodeships in the ranking and changes in these positions in 2010 as compared to 2005 are presented in table 3.

The Podlaskie Voivodeship holds the first place in the ranking in terms of environmental quality. This is an area rich in numerous natural values, where national parks form the greatest part of protected areas in Poland. As a result, in Podlaskie region rare worldwide specimen can still be found, forming biodiversity of this region. It is inhabited by the biggest number of major protected animals. The above mentioned characteristic creates a particular climate for Podlaskie region, which influences good health condition of its inhabitants and consequently determines high quality of life. The Podlaskie Voivodeship is also actively involved in promoting environmental protection. It has one of the smallest emissions of gas and dust (15th place in Poland). It uses the latest technologies for industrial and municipal sewage treatment being insofar the most effective in this activity (1st in the country). The economy of this region is water and energy saving. The Podlaskie

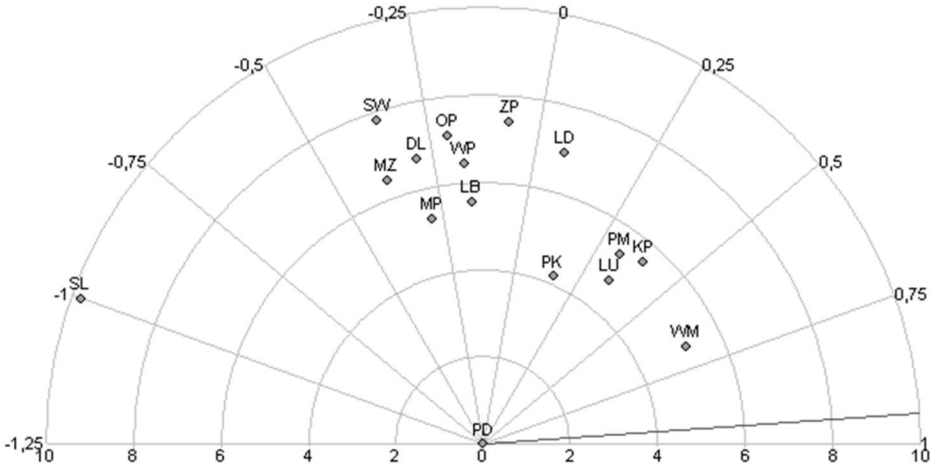

Figure 1. The map for 'The Podlaskie Voivodeship' object – a synthetic index JS_10

Source: Prepared by the author on the basis of taxonomic analysis results and Local Data Bank, www.stat.gov.pl, August 2013

Voivodeship is the leader in renewable energy production in relation to the total electric energy production (3rd in the country). The problems of this region are, however, connected with not being energetically self-sufficient and with poor waste management. The Podlasie region holds the last position in the country in terms of selective waste collection.

Figure 1 shows the distance in the environmental quality that divides the Podlaskie Voivodship from other regions in the country. The closest to the Podlaskie Voivodeship is the Warmińsko-Mazurskie Voivodeship, and the farthest – the Śląskie Voivodeship. Podlaskie is a region that includes the environmental quality in shaping regional policy. It sees the green economy as its competitive advantage in the new financial perspective of the European Union (Strategy 2013).

The second position in the ranking is occupied by the Warmińsko-Mazurskie Voivodeship. This is a tourist area, rich in natural values and biodiversity of species, including numerous major protected animals. In Warmia and Mazury region there are no national parks, but it holds eight landscape parks, which protect the nature to a lesser extent because they can be inhabited by people. This region emits the lowest amount of gas and dust pollutants in the country (16th in the country) as well as automotive pollutants resulting from using roads (16th in the country). In addition, the share of devastated and degraded areas requiring reclamation is one of the smallest in the country (15th position). It is highly probable that a relatively

clean and not degraded natural environment of the Warmińsko-Mazurskie Voivodeship influenced low activity of this region in the field of environmental protection. This voivodeship holds the last place in the country in terms of neutralization of air pollution as well as industrial and municipal sewage treatment by means of innovative methods utilizing the most recent technologies. It also incurs the lowest expenses in the country on fixed assets used for environmental protection. On the other hand, it holds the leading position in renewable energy manufacturing, although, like the Podlaskie Voivodeship, it is not a self-sufficient region in terms of energy and has the lowest efficiency of waste management, especially in selective collection in the country.

The third position is held by the Kujawsko-Pomorskie Voivodeship. This is the largest in the country manufacturer of renewable energy as compared to electric energy production in total. Similarly to Podlaskie and Warmia and Mazury regions, it is not energetically self-sufficient. The Kujawsko-Pomorskie Voivodeship has numerous natural values, including eight landscape parks, significant natural monuments as well as many objects of historical value. In terms of gas pollution, it occupies the 10th position in the country, and dust pollution – the 6th position. It neutralizes relatively low amounts of air pollution (11th in the country). Apart from that, its activity in environmental protection is quite significant. It employs advanced technologies for treating industrial and municipal sewage (4th in the country) and incurs relatively high expenses on fixed assets used for water management (4th in the country). It also has an effective waste management with regard to its selective collection (4th in the country).

The fourth position in the ranking of the environmental quality is occupied by the Lubuskie Voivodeship. It is a region where a substantial part of protected areas is occupied by national parks (6th in the country). The natural environment of this region is relatively clean. It is inhabited by numerous significant protected animals. One of the dominant fields of economic activity is agriculture. It is facilitated by the climate of the Lubuskie Voivodeship, which is favourable for running such operations. Air pollution in this region is the lowest in the country. The Lubuskie Voivodeship occupies the 14th position in terms of gas and dust pollution, although it neglects their neutralization. It actively operates in industrial and municipal sewage treatment using innovative technologies (3rd in the country) as ell as consumes the smallest amount of water from operating resources of underground waters, for the needs of the national economy and population.

The fifth position is held by the Pomorskie Voivodeship – a region with numerous natural values, including natural monuments, created mainly by

land shaping and plant biodiversity. The Pomorskie Voivodeship occupies the 4th position in the country in terms of the share of national parks in protected areas. It is also a region which is active in environmental protection. It significantly neutralizes air pollution (4th in the country) and has very effective and innovative technical infrastructure used for industrial and municipal sewage treatment (2nd in the country). It incurs relatively high expenses on fixed assets used for environmental protection (3rd in the country). Moreover, it is one of the country's leading manufacturers of renewable energy in relation to the total electric energy production (4th in the country). As with voivodeships occupying higher positions in the environmental quality ranking, the Pomorskie Voivodeship is not a self-sufficient region in terms of energy and has a poor management of waste, especially with regard to its selective collection.

The sixth position in the ranking is occupied by the Podkarpackie Voivodeship, having numerous natural values concentrated particularly in national parks, which are extremely favourable places for the growth of various plants and creation of natural monuments etc. The Podkarpacie region does not cause the heaviest air pollution (12th in the country), but its activities for retention and neutralization of pollution are hardly effective (12th in the country). Similarly, activities for environmental protection in this region, in terms of industrial and municipal sewage treatment, are not outstanding (11th in the country) as well as the expenses incurred on measures used for environmental protection (7th in the country) and water management (11th in the country). Compared to other Polish regions, the Podkarpackie Voivodeship has much better selective waste collection management (2nd in the country) and holds a large share in renewable energy manufacturing of the overall electric energy production (5th in the country).

The seventh place is held by the Łódź Voivodeship. This is an area with few natural values, but actively operating for environmental protection. The greatest value of this region constitutes numerous natural monuments (1st in the country). The Łódź Voivodeship emits almost the greatest amount of gas pollutants (2nd in the country) and dust pollutants (7th in the country); however, it retains and neutralizes it significantly (2nd in the country). It partially results from business activities of this region, in which energetics is a key sector. As a result, the Łódź Voivodship produces more than 2.5 times more energy than is consumed by the national economy and the population of the region. It is self-efficient in terms of energy (1st in the country). Due to this, the relation of renewable energy in this region to the one produced in total is small (15th in the country). Environmental protection in the Łódź Voivodeship is also reflected in using modern technologies for

industrial and municipal sewage treatment (2nd in the country) and in relatively large investment expenditures on fixed assets used for environmental protection (6th in the country).

The next – eighth position is occupied by the West Pomeranian Voivodeship (Zachodniopomorskie), which stands out in terms of investment in environmental protection and water management (1st in the country). This activity's tangible outcome is innovative technical infrastructure of industrial and municipal sewage treatment. Gas and dust pollution in this region is lower than the national average and, mainly due to the existing innovative devices, it is retained and neutralized. National parks with natural monuments dominate among natural values of the Zachodniopomorskie Voivodship. In terms of biological diversity of major protected animals, this voivodeship holds the 10th position in the country.

The Lublin region opens the second half of voivodeships, when it comes to environmental quality. It is a region with the least devastated and degraded grounds requiring reclamation, air pollution is also relatively low (13th in the country). This voivodeship has natural values that are under special protection in national parks (7th in the country); it is inhabited by various types of major protected animals (6th in the country). The Lublin Voivodeship is not especially active in nature's protection – it incurs little expenses on fixed assets used for environmental protection and water management (14th and 15th in the country respectively), has poorly developed technical infrastructure, which employs innovative technologies for sewage treatment (15th in the country), holds the last position in the country in terms of share of renewable energy manufacturing in the overall electric energy production.

The tenth position in the ranking is occupied by the Wielkopolskie Voivodeship (Greater Poland Voivodeship). The majority of detailed indexes in this region take the values of the national average. It is true with natural values and species biodiversity, air pollution emission, or investment expenses on fixed assets used for environmental protection. This is energetically self-sufficient area with low share of renewable energy manufacturing in the overall electric energy production. The Wielkopolskie region is a water consuming voivodeship – it consumes a substantial part of operating resources of underground waters for the purposes of national economy and population (4th in the country). A positive activity, leading to improvement in environmental quality of the region, is effective waste management with regard to its selective collection (3rd in the country).

The 11th place is held by the Opole Voivodeship – responsible for one of the highest gas pollution (3rd in the country) and dust pollu-

tion (2nd in the country), which is, however, well prevented and reduced (3rd in the country). Environmental degradation of this region is also high with a relatively large share of devastated grounds requiring reclamation (3rd in the country). Strong actions for improvement in environmental quality in this voivodeship include incurring considerable expenses on fixed assets used for environmental protection (4th in the country). The Opole region is self-sufficient in terms of energy, but manufactures relatively little renewable energy of the total energy produced. It has poor waste management with regard to its selective collection (11th in the country).

The twelfth position is occupied by the Małopolskie Voivodeship. This is a region with rich natural values, resulting greatly from natural topography. It holds the 3rd position in the country regarding the share of national parks in protected areas in total. Regardless of this, Małopolska is a significantly polluted region. On the one hand, it is caused by high air pollution emission: dust pollution (4th in the country) and automotive (2nd in the country), a significant amount of devastated and degraded grounds requiring reclamation (4th in the country) as well as relatively large consumption of operating underground waters for the purposes of national economy and population (5th in the country). On the other hand, it results from a relatively low activity in counteracting this degradation, e.g. bearing relatively low financial outlays and not having innovative technical infrastructure for, among others, sewage treatment. The sign of a positive action for environmental protection is selective municipal waste collection which is the most effective in Poland.

The 13th position is occupied by the Dolnośląskie Voivodeship – a region of considerable emission of dust pollution (3rd in the country) and gas pollution (6th in the country) that are neutralized to a larger extent (1st in the country). The unfavourable condition here is a relatively large number of devastated and degraded grounds requiring reclamation (2nd in the country) as well as storage of the biggest amount of non-segregated municipal waste, which is a sign of ineffective waste management in this region. Lower Silesia does not participate actively in environmental protection activities. In terms of industrial and municipal sewage treatment, by means of modern devices with increased removal of biogenic substances, it occupies the 6th position in the country. Regarding investment outlays on fixed assets used for environmental protection – the 11th, and for water management – the 7th. The Dolnośląskie Voivodeship occupies the last position in the country in terms of legally protected areas, in which national parks constitute only 13% (9th in the country).

The fourteenth position is occupied by the Świętokrzyskie Voivodeship that emits relatively large amounts of air pollution: gas (4th in the country) and dust (5th in the country) that is, to a significant extent, not prevented and neutralized. This is the most water consuming region in Poland, rarely treating industrial and municipal sewage by means of modern infrastructure. As the only voivodeship, it does not possess a sewage treatment plant with the capacity sufficient for all its inhabitants. The Świętokrzyskie region is energetically self-sufficient and the share of the manufactured renewable energy in the overall electric energy production is average (7th in the country). The strength of this region is also sizeable investments in fixed assets used for environmental protection (2nd in the country). Additionally, the region is inhabited by numerous significant protected animals (3rd in the country), and legally protected areas occupy the largest part of the voivodeship's area in Poland.

The fifteenth place is occupied by the Mazowieckie Voivodeship, which is the leader in economic and social development. Unfortunately, in the environmental and spatial aspect, it holds a very distant position, which proves that this is not a region developing in a sustainable way in all the three fields. Environmental quality of the Mazowieckie Voivodeship is relatively low. It is mainly caused by substantial emissions of air pollution, mainly gas (5th in the country) and automotive (4th in the country), low effectiveness of treating industrial and municipal sewage (13th in the country), substantial consumption of operating ground waters for the needs of population and national economy (2nd in the country) as well as relatively ineffective waste management (4th in the country in terms of the number of non-segregated municipal waste collected during the year, and the 6th position in terms of their selection). The Mazowsze region is not self-sufficient in terms of energy and the share of manufactured renewable energy in the overall electric energy production is low (13th in the country). The advantages of this region are many natural values, such as national parks (5th in the country), natural monuments or places of historical significance.

The last position in the ranking in terms of environmental quality is occupied by the Śląskie Voivodeship that has the most degraded natural environment in Poland. It has the highest gas, dust and automotive pollution emission. It hardly retains and neutralizes this pollution, which causes that the number of cardiovascular diseases and malignant tumors as well as the level of mortality resulting from them is the highest in Poland. This region also has the most destroyed and degraded grounds requiring reclamation. At the average level, there are only indexes concerning water quality management and its consumption. Silesia does not have many natural

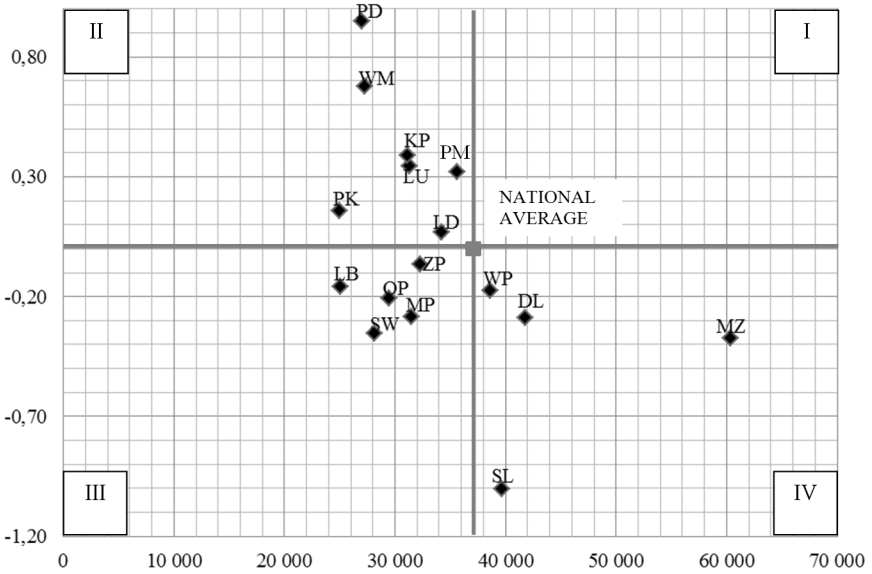

Figure 2. Gross Domestic Product in zloty per capita and the quality of the environment in Polish regions in 2010[11]

Source: Prepared by the author on the basis of taxonomic analysis results and Local Data Bank, www.stat.gov.pl, August 2013

values and significant protected animals are rarely found here in comparison to other regions in Poland.

Figure 2 presents the dependence between the level of economic development of Polish regions expressed by gross domestic product in zloty per capita and the environmental quality in 2010. The first quarter contains no voivodeships, which means that no Polish voivodeship is characterized both by high environmental quality and high level of economic development at the same time. The second quarter includes seven voivodeships. These are regions of high environmental quality, but lower than average level of economic development. The third quarter includes five regions with the lowest level of both the environmental quality and the economic development. These are regions in the most difficult economic and environmental situation. The last quarter contains four economic leaders whose development carries environmental degradation.

4. Conclusion

The purpose of this article was to create the synthetic environmental quality index, on the basis of which the impact of the natural environment on

shaping development policy of Polish voivodeships could be examined. The obtained results clearly prove that the quality of the environment of Polish regions is inversely associated with the level of economic development of the researched local government units. It means that in the period between 2005 and 2010, the majority of Polish voivodeships, possessing relatively high environmental quality, developed less dynamically. It was mainly the result of not including this factor when the regional policy was formulated. In case of particular regions, such as the Podlaskie Voivodeship, the vast protected areas formed a barrier to development of transport infrastructure, which is undoubtedly crucial for accessibility of the region.

The highest positions in the ranking were occupied by voivodeships characterized by the lowest value of gross domestic product per capita, being the least innovative and providing the lowest financial investment per inhabitant. These are: the Podlaskie Voivodeship and the Warmińsko-Mazurskie Voivodeship. The last places in the ranking, on the other hand, are held by regions with the most polluted environment, but which are, at the same time, leaders of economic development, i.e. Mazowieckie and Śląskie Voivodeships. During five years, there have been no considerable changes in the positions of voivodeships in the ranking in terms of environmental quality. The most substantial differences concern two regions: Opole (drop by three positions) and Małopolskie (rise by three positions). However, these are still the regions with economic development and environmental quality below the national average. Undoubtedly, long term analysis – lasting several dozen years – would reveal greater changes, but it is impossible to be done due to unavailability of statistical data.

Among the sixteen Polish voivodeships, only one seems to be able to shape regional development and at the same time pay particular attention to the natural environment. It is the Pomorskie Voivodeship, which has been recently marked with high dynamics of economic growth. It has numerous natural values and a relatively low level of environmental pollution. Additionally, it actively acts to provide for the protection of the environment. Although the level of development of this region is still below the national average, its high pace indicates that in the nearest future it will be the first region in Poland that properly uses the natural environment in shaping high level of economic development.

The new financial perspective of the European Union and its policy, which is concentrated on low-carbon and green economy as well as human-friendly approach that counteracts social exclusion and improves the quality of life, allows us to predict the growing interest of the Polish voivodeships

in conducting environmentally friendly economic development. It should be stated that, as is indicated both by theory and practice of economics, in this situation the economic factor is the most effective.

NOTES

[1] For more information see the following articles: Blaug 2000, s. 104–159, Żurawicki 1979, p. 80–91.

[2] See more: Blaug 2000, p. 192–231, Fischer 1976 after Fiedor 2002.

[3] See more: Fiedor 2002, p. 8.

[4] See more: Fiedor 2002, p. 197–223.

[5] Calculations were done with the use of the following programs: 'Numerical Taxonomy' designed by K. Kolenda from Wrocław University of Economics, Excel and GRETL (Kufel 2011).

[6] There are also formal methods of determining the nature of indexes (Grabiński 1985). The starting point of statistical procedures is a matrix of correlations between particular observable variables. All stimulants should be positively correlated, destimulants also positively, while correlation coefficients between the stimulants and destimulants should be negative. The correlation between a variable of any type and the nominant should be irrelevant (Mierzyńska 2000, p. 16).

[7] While choosing formulas for changing destimulants into stimulants and nominants into stimulants, calculations were made on the basis of a couple of formulas present in the 'Numerical Taxonomy' program. In any case, the results were approximate and had no influence on final conclusions.

[8] Kolenda 2006, p. 25–26.

[9] In the analyses of a relatively large number of variables and objects, the proportionality measure is additionally applied. It was suggested by B. Kostrubiec $D_i = \sum_{j=1}^{k} |C_{ij}|$ (Kostrubiec 1965).

[10] The main criterion for the selection of years to be analyzed was the availability of statistical data concerning every analyzed diagnostic variable as well as the possibility to perform dynamic analyses.

[11] Symbols in the figure mean voivodeships: DL – dolnośląskie, KP – kujawsko-pomorskie, LB – lubelskie, LU – lubuskie, LD – łódzkie, MP – małopolskie, MZ – mazowieckie, OP – opolskie, PK – podkarpackie, PD – podlaskie, PM – pomorskie, SL – śląskie, SW – świętokrzyskie, WM – warmińsko-mazurskie, WP – wielkopolskie, ZP – zachodniopomorskie.

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