THE MEASUREMENT OF THE QUALITY OF THE ENVIRONMENT AND ITS DETERMINANTS IN POLAND IN THE REGIONAL PERSPECTIVE

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Abstract: *The main motivation to undertake the research was the search for tools allowing for the evaluation of government policies in the field of environmental quality. Showing which type of support for certain types of activities or pro-environmental investments may lead to improvement of the quality of the environment can be very important in order to improve the effectiveness of this policy. The aim of this paper is to determine factors shaping the quality of the environment in the regional perspective. The realization of the aim of the publication was preceded by computing composite measures for four dimensions which constitute the quality of the environment, i.e. biodiversity, soil, water and air. The determinants considered in the aim of the study were divided into the groups of technical and financial determinants (expenditures on activities related to the improvement of the environment quality). The analysed territorial units (poviats) were divided into 4 equilateral classes, according to the increasing environmental quality measure. The applied MANOVA analysis proved that between the classes the majority of variables used in the analyses showed the significant differences between classes. However, higher investment and financial outlays were mainly associated with lower quality of the environment with regard to local government policy. On the other hand green schemes of the Common Agricultural Policy of the EU seem to contribute to improving the environment.*

Keywords: cost-effectiveness, composite index of the environmental prospects, MANOVA, pollution, environmental policy

JEL: A10, Q00, Q15

Introduction

The economic analysis of the ex-post environmental policy deals with providing an answer to the question whether the assumed environmental policy objective has been achieved effectively. At the European Union level, ex-post evaluations are not often carried out, and the information from such evaluations is very rarely used. The European Union law directly requires the systematic evaluation of the profitability of activities carried out with the European funds. (Görlach et al., 2007).

The most frequently discussed environmental issues include: acidification, air quality, biodiversity, climate, changes in soil chemical composition, precipitation and water. Sometimes these studies included the noise and ozone levels. (Görlach et al., 2007). The very frequent objections to the evaluation of public policies indicate that more attention is paid to the analysis of costs and benefits rather than to the analysis of cost-effectiveness, the guidelines for the cost-effectiveness analysis are usually focused on the ex ante analysis, treating the ex post analysis as a

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specific case. The guidance documents when focused on the ex post policy evaluation, usually provide little information, refer to the evaluation process very generally (Görlach et al., 2007).

In the recent years, there has been a strong commitment towards better integration of economic and environmental objectives. This commitment has led to more effective environmental, economic and sectoral policies which show an increasing level of sensitivity to the environmental realities. We are observing a widespread use of environmental impact assessment procedures and an increasing use of economic approaches to the environmental policies, an example of which may be the transferable permit systems for the environmental pollution control (OECD, 2008). The environmental degradation depends on the total amount of pollution caused by the economic activity and may also be limited by the government's policy expressed in tax and expenditure policies and the control system, these activities have a significant impact on the effectiveness of the environmental policy (Afonso, 2005).

The European policy assumes that governments should seek the effective and efficient environmental policies focusing on finding a balance between the environmental, economic and social policy objectives (OECD, 2008).

The recent trends related to the reduction of emissions of all substances harmful to the environment require a specific approach to improve the effectiveness of expenditures incurred on the environmental protection. The improvement of the effectiveness of the expenditures should result in striving to reduce the greenhouse gas emissions and the designation of the main determinants of environmental protection, which subsequently should contribute to the formulation of effective policy measures (Risch and Salmon, 2017).

In the recent years, the new social expectations have emerged regarding the functions of the common agricultural policy, which are expressed in the fact that agricultural lands should purify and regulate water resources and accumulate organic carbon in order to contribute to the preservation of climate change. Furthermore, the agricultural sector should ensure the protection of biodiversity and promote a sustainable nutrient cycle. These expectations have been translated into a significant number of social policies that directly or indirectly support the environmental quality (Schulte et al., 2019).

In some cases, the level of the economic growth, the energy consumption, the foreign direct investment and the openness of trade are the determinants of the environmental quality (Zakaria and Bibi, 2019).

Research on the effectiveness of the environmental policy has already been carried out in the area of analysis of 39 countries using the DEA method by other researchers (Adam and Tsarsitalidou, 2019). In the above-mentioned studies, the main focus was on the political footprint affecting the quality of the environment. These studies took into account the urbanisation rate, GDP per capita, the level of democracy and the quality of bureaucracy, recognizing that the listed variables have an impact on the effectiveness of the environmental policy. As a result of these studies, it was found that at low income levels the effect of democracy is negative, whereas at high income levels it becomes positive (Adam, 2007).

The research undertaken in this article focuses on the search for tools to monitor the progress of environmental policies by searching for tools enabling the assessment of the effectiveness of governments' performance in this regard.

Taking into account the literature data and own research experience, the factors influencing the environmental quality measure were selected. These factors can be divided into two groups, i.e. tangible investments and financial outlays related to the environmental quality.

Taking into account the above mentioned data, the formulation of the aim of this publication included the determination of composite measures of four orders (biodiversity, soil, water, air) and the impact of both tangible investments and financial outlays on the environmental quality measure.

Methods

The variables to be analyzed came from the databases available on the Internet portal of the Central Statistical Office (downloaded on 05-30 September 2019) and from the Institute of Soil Science and Plant Cultivation in Puławy. The analysis covered 312 poviats in Poland. The time period used in the analysis of the variables was varied and ranged from 1999 to 2017.

Then, a synthetic measure of the quality of the environment was developed by means of the CRITIC-TOPSIS method (Technique for Order Preference by Similarity to an Ideal Solution) (Wysocki, 2010).

Table no. 1. List of variables and their weights in the synthetic meters

Name of the variable	Weight in the order meter	Type of order	Weight in the environmental quality index
agricultural plant cover diversity	0.18	biodiversity	0,261515
permanent meadows - % of the poviat area	0.17		
permanent pastureland - % of the poviat area	0.19		
total forests - % of the poviat area	0.17		
sum of the urban green areas - % of the poviat area	0.15		
high nature value farmland index	0.14		
value of water erosion in t/ha/year according to RUSLE2015 model	0.29	soil	0,303650
the content of trace elements (metals) in the top layer of the arable land (0-20 cm) in mg kg1 - Cadmium	0.13		
the content of trace elements (metals) in the top layer of the arable land (0-20 cm) in mg kg1 - Copper	0.21		
the content of trace elements (metals) in the top layer of the arable land (0-20 cm) in mg kg1 - Nickel	0.24		
the content of trace elements (metals) in the top layer of the arable land (0-20 cm) in mg kg1 - Lead	0.14		
biochemical oxygen demand- industrial pollutant loads (IPL) discharged into waters or into the ground (kg/y/ha)	0.09	water	0,223449
chemical oxygen demand IPL (kg/y/ha)	0.09		
total suspension IPL (kg/y/ha)	0.10		
sum of chlorides and sulphates ions IPL (kg/y/ha)	0.08		
volatile phenols IPL (kg/y/ha)	0.09		
total nitrogen IPL (kg/y/ha)	0.10		
total phosphorus IPL (kg/y/ha)	0.09		
biochemical oxygen demand - municipal pollutant loads (MPL) in wastewater after treatment (kg/y/ha)	0.09		
chemical oxygen demand MPL (kg/y/ha)	0.09		
total suspension MPL (kg/y/ha)	0.01		
total nitrogen MPL (kg/y/ha)	0.01		
total phosphorus MPL (kg/y/ha)	0.14		
annual average PM10 - rural areas	0.53	air	0,211385
emission of gasous pollutants from industry (t/y)	0.20		
emission of dust pollutants from industry (t/y)	0.27		

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

The variables for the construction of the environmental quality measure were selected on the basis of the analysis of literature reports (Table 1). From among the set of variables acceptable for the formation of the synthetic measure of the quality of the environment, those variables which were characterised by sufficient level of the coefficient of variance and were not excessively correlated with other coefficients were selected. Correlation was assessed by means of a correlation matrix between the variables and then an invertible matrix. Next step was the analysis of the diagonal elements of the invertible matrix. It was established that values exceeding 10 determine improper condition number of the matrix and thus excessive correlation of a particular feature with the other features (Czyżewski and Kryszak, 2017).

At the next stage, the variables qualified for the synthetic measure of the quality of the environment were subjected to zero unitarization, and destimulants were converted into stimulants (all the variables save for the population of endangered bird species and habitats variable, which was classified as a stimulant). The unitarization was performed according to the following formulae:

$$- \, stimulants: z_{ij} = (x_{ij} - \min_i\{x_{ij}\}) / (\max_i\{x_{ij}\} - \min_i\{x_{ij}\}), (i = 1,2,\dots,n; j = 1,2,\dots,m);\ z([0,1] \quad (1)$$

$$- \, destimulants: z_{ij} = (\max_i\{x_{ij}\} - x_{ij}) / (\max_i\{x_{ij}\} - \min_i\{x_{ij}\}), (i = 1,2,\dots,n; j = 1,2,\dots,m);\ z([0,1] \quad (2)$$

where: $\min_i\{x_{ij}\}$ – minimum value of j feature, $\max_i\{x_{ik}\}$ – maximum value of j feature, i – object (in this case country).

Then, weights for particular coefficients were determined by means of the CRITIC method (*Criteria Importance Through Intercriteria Correlation)* (Diakoulaki et al., 1995); (Deng et al., 2000). Similarly to the works of (Bieniasz et al., 2013, Czyżewski and Kryszak, 2017), an assumption that the influence of particular simple features on the value of synthetic measure of the quality of the environment is not identical was made. In the CRITIC method, weight coefficients are determined on the basis of standard deviations and correlation between the coefficients. A distinctive feature of this method is assigning relatively higher weights to features which are characterised by a high rate of variability and simultaneously low correlation with other features. The weight coefficients were determined according to the following formulae:

$$w_j = \frac{c_j}{\sum_{k=1}^{m} c_k}, j = 1,2,\dots,m;\ c_j = s_{j(z)} \sum_{k=1}^{m} (1 - r_{ij}), j = 1,2,\dots,m \quad (3)$$

where: cj – measure of informational capacity of j feature, sj(z) – standard deviation calculated out of the standardised values of j feature, rij – correlation coefficient between j and k features. The sum of the coefficients is 1. Next step was multiplication of the determined standardised values of simple features by relevant weight coefficients.

At the next stage, calculation of Euclidean distances of particular units from the pattern and anti-pattern of development was performed. The calculation of Euclidean distances was performed according to the following formulae:

$$d_i^+ = \sqrt{\left(\sum_{j=1}^{k} (z_{ij}^*) - z_{ij}^+\right)^2} - distance\ from\ the\ pattern\ of\ development \quad (4)$$

$$d_i^- = \sqrt{\left(\sum_{j=1}^{k} (z_{ij}^*) - z_{ij}^-\right)^2} - distance\ from\ the\ anti-pattern\ of\ development \quad (5)$$

where:

$$z_j^+ = \left(\max(z_{i1}^*), \max(z_{i2}^*), \dots, \max(z_{ik}^*)\right) = (z_1^+, z_2^+, \dots, z_k^+)$$

$$z_j^- = \left(\min(z_{i1}^*), \min(z_{i2}^*), \dots, \min(z_{ik}^*)\right) = (z_1^-, z_2^-, \dots, z_k^-)$$

At the next stage, the value of q_1 synthetic feature was determined according to the following formula:

$$q_i = \frac{d_i^-}{d_i^+ + d_i^-}, (i = 1,2,\dots,n) \quad (6)$$

After the environmental quality measure was computed, MANOVA analysis was carried out using this measure as an independent variable. The aforesaid analysis was based on 32 variables (Table 2). The analyzed territorial units (powiats) were arranged in the ascending order according to the environmental quality measure and then divided into four equilateral classes (78 poviats in one class). Class A consisted of poviats with the lowest environmental quality and class D of poviats with the highest environmental quality. The analysis of MANOVA variance was validated by the multidimensional significance tests of Wilks, Pillai, Hotelling, and Roy. The whole research procedure was directed at the performing post-hoc comparisons and calculation of contrasts between the analysed classes. The results of these analyses are presented in Table 3-7.

Results

The zero hypothesis indicating the lack of differentiation of the multivariate space in the chosen classes of poviats was rejected using the multidimensional tests of Wilks, Pilai, Hotelling and Roy (Thompson, 1995). The results of each of the conducted tests strongly indicate that the set of variables under study proved to be statistically significant (Table 2).

Table no. 3. Results of multidimensional significance tests

Test no.	Multivariate Tests of Significance for Planned Comparisons. Specified multivariate tests					
	Test	Value	F	Effect df	Error df	p
1	**Wilks**	**0,085720**	**10,99892**	**96**	**830,0978**	**0,00**
2	**Pillai's**	**1,207023**	**5,86942**	**96**	**837,0000**	**0,00**
3	**Hotellng**	**7,493539**	**21,51791**	**96**	**827,0000**	**0,00**
4	**Roy's**	**7,084865**	**61,77117**	**32**	**279,0000**	**0,00**

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

The taxonomic analysis conducted between the classes of poviats indicates that from the group of variables classified as the tangible investments, in the case of four variables the significant differences occurred (the length of the water supply system (km), afforestation - public forests, afforestation - private forests). In the case of the variable, the length of the sewage disposal installation, the significant difference occurred between class A and D and amounted to 166.62 km in favour of class A (Table 2). Moreover, the significant differences between classes B and D were found in the case of two variables, i.e. the length of rainwater drainage system (km) (the value higher by 7.95 km in class B) and the planting of greenery - bushes (the value higher by 9170.94 in class B) (Table 2).

Table 4: Average sizes of the variables within the analytical classes (significant post-hoc comparisons are bolded) **

Class	N	Variables *					
		x_1	x_2	x_3	x_4	x_5	x_6
A	78	↑230044,4	10142,10	**↑414,41**	23,80	6821,19	4074,63
B	78	30581,6	↑21982,38	284,43	**↑26,80**	↑7367,92	5553,87
C	78	↓21097,8	8804,01	↓260,86	19,18	6639,41	↑6461,80
D	78	↓21097,8	↓6534,21	**247,79**	**↓18,85**	↓5344,99	↓5417,86
Total	312	66618,9	11865,67	301,87	22,16	6543,38	5377,04
		x_7	x_8	x_9	x_{10}	x_{11}	x_{12}
A	78	**281,03**	5488,85	2547,45	**↓87,39**	**↓214,13**	6654,59
B	78	**↓276,95**	↑12149,41	3176,08	**116,35**	**295,78**	↑7564,27
C	78	**299,74**	↓951,85	↑3964,91	**271,43**	**386,42**	6264,73
D	78	**↑364,42**	1057,77	↓148,24	**↑514,43**	**↑563,30**	↓5654,47
Total	312	305,53	4911,97	2459,17	247,40	364,91	6534,52
		x_{13}	x_{14}	x_{15}	x_{16}	x_{17}	x_{18}
A	78	21154,42	**↓4790458**	**↓14119061**	**↓1612118**	**↓17157782**	**↓868450**
B	78	**25760,56**	**8822608**	**26642302**	**2218035**	**26244163**	**1063569**
C	78	↑23851,83	**12801656**	**37244388**	**2528657**	**27889586**	**1087521**
D	78	**↓16589,62**	**↑19954392**	**↑58407507**	**↑3924469**	**↑49491232**	**↑1887388**
Total	312	21839,11	11592279	34103314	2570820	30195691	1226732
		x_{19}	x_{20}	x_{21}	x_{22}	x_{23}	x_{24}
A	78	**↓2041087**	**↓2012826**	**↓161586,2**	**↓219112,4**	**↓1886401**	**↓361914**
B	78	**2864955**	↑10023214	**380363,3**	**327140,6**	**2634445**	**597650**

Class	N	Variables *					
		x_1	x_2	x_3	x_4	x_5	x_6
C	78	**3011803**	8827967	**425348,7**	**366105,4**	**2551212**	**838020**
D	78	**↑4992020**	**9559498**	**↑749151,1**	**↑608083,2**	**↑4425155**	**↑2543751**
Total	312	3227466	7605876	429112,3	380110,4	2874304	1085334
		x_{25}	x_{26}	x_{27}	x_{28}	x_{29}	x_{30}
A	78	**↓3114803**	**22583206**	10651459	**↑6185534**	**↑103347480**	**↑39521219**
B	78	**5040425**	↑16912370	**↑11368663**	4217744	71301358	31417411
C	78	**6641256**	14479413	9868463	2949884	59806400	27166872
D	78	**↑10680403**	**↓14393518**	**↓7497596**	**↓2340848**	**↓56260322**	**↓26539323**
Total	312	6369221	17092127	9846545	3923502	72678890	31161206
		x_{31}	x_{32}	x_{33}			
A	78	**↑0,052143**	↑99694,51	**↓0,542460**			
B	78	0,043823	84223,50	**0,640640**			
C	78	↓0,043528	74556,04	**0,698989**			
D	78	**0,044424**	↓66416,67	**↑0,772906**			
Total	312	0,045980	81222,68	0,663749			

*__tangible investments__ **x_1**- waste management efficiency - storage sites (t/y), **x_2** - capacity of sewage management, capacity of water protection, capacity of sewage treatment plants (m3/day), **x_3** - length of sewage disposal installation (km), **x_4** - length of rainwater disposal installation (km), **x_5** - efficiency of water intakes (m3/day), **x_6** - water treatment capacity per day (m3), **x_7** - length of water supply system (km), **x_8** - capacity of installed equipment and installations for reduction of dust pollution (t/y), **x_9** - capacity of installed equipment and installations for reduction of gaseous pollution (t/y), **x_{10}** - afforestation - public forests (ha, years 2000-2017), **x_{11}** - afforestation - private forests (ha, years 2000-2017), **x_{12}** - planting greenery - trees in cities and rural areas (pcs, years 2004-2017), **x_{13}** - planting greenery - bushes in cities and rural areas (pcs., years 2004-2017)), **financial outlays CAP** x_{14} - LFA payment (years 2004-2006), **x_{15}** - support for less favoured areas (LFA in the years 2007-2013), **x_{16}** - agri-environmental payments (years 2004-2006), **x_{17}** - agri-environmental payments (years 2007-2013), **x_{18}** - afforestation of arable lands (2004-2006), **x_{19}** - afforestation of arable lands and afforestation of lands other than arable lands (2007-2013), **x_{20}** - outlays on adaptation of agricultural holdings to the standards of the European Union (2004-2006), **x_{21}** - outlays on the use of advisory services by farmers and forest holders (2007-2013), **x_{22}** - outlays on investments in the development of forest areas and improvement of forest vitality (2007-2013), **x_{23}** - outlays on agri-environmental and climatic measures (2007-2013), **x_{24}** - outlays on organic farming (2007-2013), **x_{25}** - payment for areas with natural constraints or other specific constraints, **financial outlays of local government x_{26}** - expenditure under chapter 90003 - urban and rural purification (sum 2002-2017, 2002=100), **x_{27}** - expenditure under chapter 90004 - maintenance of green areas in cities and municipalities (sum 2002-2017, 2002=100), **x_{28}** - expenditure under chapter 90005 - protection of ambient air and climate (sum 2002-2017, 2002=100), **x_{29}** - expenditure under chapter 90001 - sewage management and water protection (sum 2002-2017, 2002=100), **x_{30}** - expenditures under chapter 90002 - municipal waste management (sum 2002-2017, 2002=100), **control variables x_{31}** - share of environmental expenditures in total revenues 2002-2017)), x_{32} – population density **predictor x_{33}** - total environmental quality,

** ↑ means the maximal value of the variable, ↓ means the minimal value of the variable; the subsequent categories of the variables are marked in different colours.

Source: Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

The taxonomic analysis of the group of variables "the financial outlays" indicates that as many as 11 variables in this group (marked in bold font in Table 2) shows the significant differences between all classes, although CAP variables have different direction when it comes to the potential influence on the environment quality (positive correlation) than a local government spending (with negative correlation). One variable (expenditures under chapter 90004 - maintenance of green areas in cities and municipalities) shows significant differences between classes B and D (Table 2). The other variables (expenditures on adaptation of agricultural holdings to the standards of the European Union, expenditures under chapter 90003 - urban and rural purification, expenditures under chapter 90004 - maintenance of greenery in cities and municipalities, expenditures under chapter 90005 - protection of atmospheric air and climate, expenditures under chapter 90002 - municipal waste management, share of environmental expenditures in total revenues) show the significant differences between classes A and D (Table 4-6).

Table 5. Contrast estimates for total local government expenditures on the environment in the classes of the composite environmental index

Contrast	Local government environmental expenditures					
	Estimate	Str.Err	t	P	-95,00% Cnf.Lmt.	+95,00% Cmf.Lmt.
CONTRAST 1 (A vs. D, tj. 1;0;0;-1)	**75257291**	**15758330**	**4.775715**	**0.0000**	**44249689**	**106264894**

Contrast	**Local government environmental expenditures**					
	Estimate	Str.Err	t	P	-95,00% Cnf.Lmt.	+95,00% Cmf.Lmt.
*SSkontrast/SSefekt	0.042119549 (86,99%)					
CONTRAST 2 (B vs. D, tj. 0;1;0;-1)	**28185939**	**15758330**	**1.788637**	**0.07476**	**-2821663**	**59193541**
*SSkontrast/SSefekt	0.005908151 (12,20%)					
CONTRAST 3 (C vs. D, tj. 0;0;1;-1)	7239425	15758330	0.459403	0.6463	-23768177	38247027
*SSkontrast/SSefekt	0,000389758 (0,80%)					

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

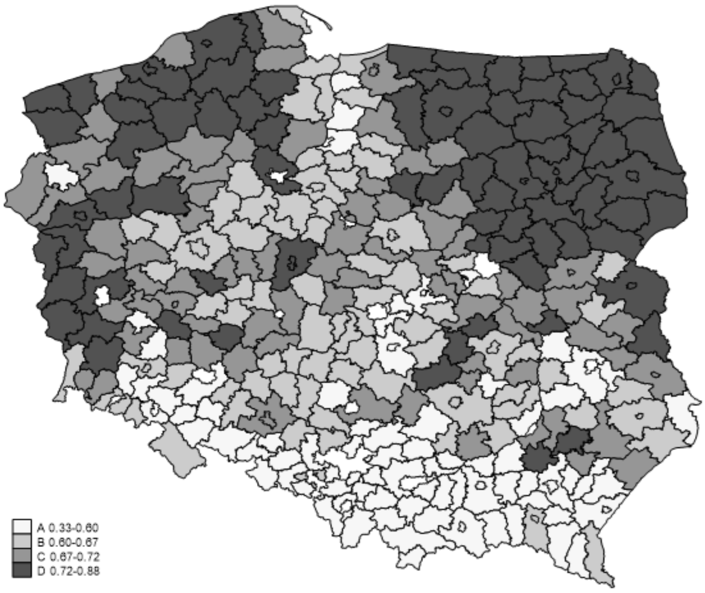

Figure 1: Distribution of the analysed territorial units (poviats) according to the Composite Measure of Environmental Quality

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

An interesting problem is the distribution of poviats due to the value of the environmental quality index (Figure 1). Classes C and D are found in the regions with the highest level of afforestation in Poland, however, the low environmental quality indexes in the region of southern Poland are surprising - it is a region of high afforestation (mountainous) and often devoid of the industry (Figure 1).

The results obtained in other studies indicate that the quality of the environment is adversely affected by the population density, while the degree of urbanisation indicates an improvement in the quality of the environment. This may be related to the effect of scale in terms of environmental policies, observed in particular in urban areas (Adam and Tsarsitalidou, 2019). The analysis of the population in the particular classes indicates that the highest number of inhabitants was in poviats classified as class A (99 694), i.e. poviats with the lowest quality of the environment; in the subsequent classes together with the increase in the population the environmental quality measure decreased, and so in class B 84 223 people were found on average, in class C 74 556 people and in class D 66 416 people (the highest quality of the environment). These analyses confirmed the conclusions of Adam and Tsarsitalidou (2019) indicating that the quality of the environment is adversely affected by the population density, as in the discussed analyses the highest population density (1.36 people per ha) was found in class A with the lowest environmental quality, in class B the population density was 0.94 people per ha, in class C the population density was 0.75 people per ha and in class D the population density was 0.52 people per ha and at the same time it is the class with the highest environmental quality.

To conclude, the most striking point is a significant inverse correlation of the environment quality and the tangible as well as financial outlays realized by local governments (the higher outlays, the lower quality). It may lead to the conclusion that ex-post effectiveness of the local governments is very low. In other words they undertake only an ex-post action to struggle with the pollution. Contrarily, long-term CAP environmental schemes succeeded in sustaining the high nature value farmland in poviats where they were allocated. This phenomenon is depicted in Figure 2 and also validated by the contrast in Table 6

Table 6. Contrast estimates for CAP environmental schemes in the classes of the composite environmental index

Kontrast	CAP funds					
	Estimate	Str.Err	t	p	-95,00% Cnf.Lmt.	+95,00% Cmf.Lmt.
KONTRAST 1 (A vs. D, tj. 1;0;0;-1)	**-118877451**	**10174228**	**-11,6842**	**0,0000**	**-138897239**	**-98857663**
*SSkontrast/SSefekt	0,049189367 (57,54%)					
KONTRAST 2 (B vs. D, tj. 0;1;0;-1)	**-80364178**	**10174228**	**-7,8988**	**0,0000**	**-100383966**	**-60344390**
*SSkontrast/SSefekt	0,02248005 (26,30%)					
KONTRAST 3 (C vs. D, tj. 0;0;1;-1)	**-63009527**	**10174228**	**-6,1931**	**0,0000**	**-83029315**	**-42989739**
*SSkontrast/SSefekt	0,013819257 (16,17%)					

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

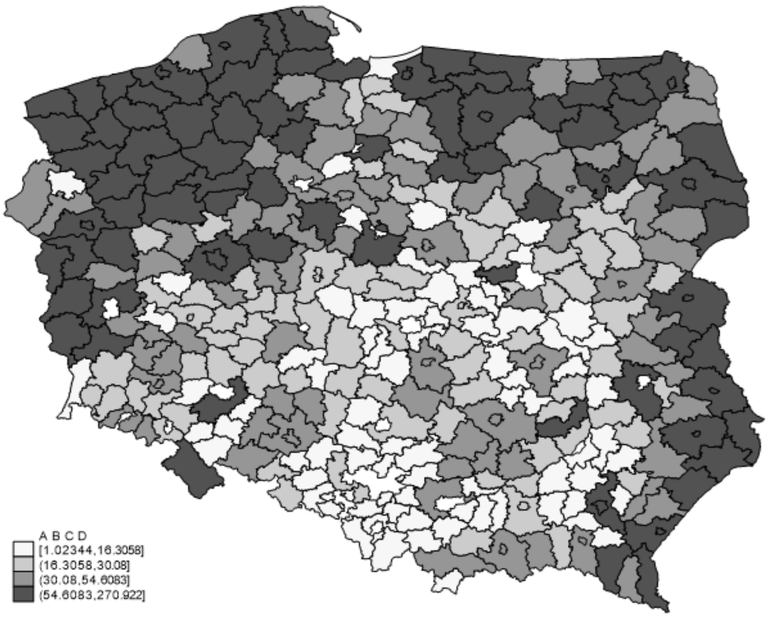

Figure 2: Distribution of the analysed territorial units (poviats) according to the CAP environmental schemes allocation in 2004-2013.

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

However it is still surprising that the value of so called "environmental expenditures" in all its range is negatively correlated to the environmental quality, bearing in mind that we deal with long term data. To explore in depth this observation we calculated contrasts for those spending related to the population (per capita). As it is presented in Table 7, the changes of the total expenditures per capita are insignificant in the consecutive classes of the environmental index.

Table 7. Contrast estimates for total local government expenditures on the environment per capita in the classes of the composite environmental index

Contrast	**Local government environmental expenditures per capita**					
	Estimate	Str.Err	t	p	-95,00% Cnf.Lmt.	+95,00% Cmf.Lmt.
CONTRAST 1 (A vs. D, tj. 1;0;0;-1)	17,33295	11,72499	1,478292	0,1404	-5,7383	40,40416
*SScontrast/SSeffect	0,027852515 (94,09%)					
CONTRAST 2 (B vs. D, tj. 0;1;0;-1)	0,08118	11,72499	0,006924	0,9945	-22,9900	23,15239
*SScontrast/SSeffect	0,0000006110 (0,002%)					
CONTRAST 3 (C vs. D, tj. 0;0;1;-1)	-4,34276	11,72499	-0,370385	0,7114	-27,4140	18,72845
*SScontrast/SSeffect	0,0017484415 (5,91%)					

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

To be accurate one should notice that there are only two categories of municipal expenditures per capita related to the environment that significantly vary between classes A-D: those on the sewage management and water protection and the maintenance of green areas in cities and municipalities. Nevertheless only the latter may positively influence to the environment quality due to its positive correlation to the composite index (cf. Table 8 and Figure 3) but their contribution is hardly significant and extremely weak (R^2=0.015)

Table 8. Maintenance of green areas in cities and municipalities (sum 2002-2017, 2002=100) Probability for test post-hoc NIR.

	class	**{1}**	**{2}**	**{3}**	**{4}**
1	A		0.215466	**0.086586**	0.590718
2	B	0.215466		0.635841	0.480221
3	C	**0.086586**	0.635841		0.237095
4	D	0.590718	0.480221	0.237095	

Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

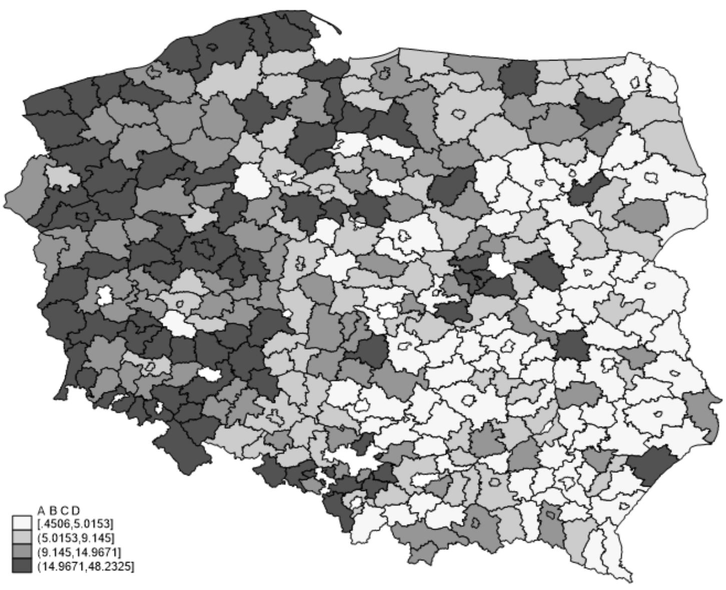

Figure 3: Distribution of the analysed territorial units (poviats) according to the local expenditures on the maintenance of green areas in cities and municipalities in 2002-2017.
Source: Own elaboration based on the Statistics Poland, IUNG PIB, IERIGŻ PIB, GDOS in Poland

Conclusion

The methodical part of this publication has discussed the algorithm of creating the environmental quality meter, then the obtained meter has been verified in the analytical part covering a sample of as many as 312 poviats. The obtained results allow to recommend the obtained environmental quality measure as a complementary tool for the assessment of ex-post effectiveness of environmental policy.

The conducted analyses have allowed to identify the determinants shaping the quality of the environment with the division into the tangible investments and the financial outlays. In the group of the tangible investments, the following can be considered as the determinants of the environmental quality: the length of the water supply system, afforestation - public forests, afforestation - private forests, whereas the determinants of the environmental quality in the group of the financial outlays can be considered: LFA payment, support for the management in mountain areas and other less-favoured areas, agri-environment payments, afforestation of agricultural lands and afforestation of non-agricultural lands, expenditure on the use of advisory services by farmers and forest holders, expenditures on investments in the forest area development and the improvement of forest vitality, expenditures on agri-environment-climate measures, expenditures on organic farming, payment for areas with natural constraints or other specific constraints. It is however worth noting that only CAP policy seems to be effective in terms of contributing to the sustainable development. National, local expenditures, except the maintaining of green areas are rather shaped ex post and positively negatively correlate to the environment quality

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