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DIAGNOSIS OF THE STATE AND FUNCTIONING OF THE ENVIRONMENT IN THE ZACHODNIOPOMORSKIE VOIVODESHIP

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Purpose: The research in the article was conducted to diagnose the state of environmental protection in the West Pomeranian region, that is, to get an answer to the question in which districts the state of environmental protection was at the best level in which the situation was worse.
Design/methodology/approach: The article classifies 21 counties of the West Pomeranian region in terms of the state of environmental protection in 2020. The counties were divided based on the taxonomic development measure as a tool for classifying socio-economic objects.
Findings: The study showed that the best state of environmental protection was characterized by the districts of Sławieński, Choszczeński, Police, and the city of Koszalin. The worst state of environmental protection was characterized by the districts of Pyrzyce, Kamienski, and the city of Szczecin.
Research limitations/implications: A taxonomic study conducted based on a set of variables that do not contain the most relevant characteristics (due to lack of statistical data) of the studied phenomenon may lead to an erroneous assessment of reality is the most significant limitation of this article.
Practical implications: The presented study can be used at the regional level to assess environmental problems and determine corrective and counteracting actions to the current situation.
Social implications: The results of the study make it possible to revise the actions of environmental policy realized in the West Pomeranian Voivodeship.
Originality/value: This study is an independent and comprehensive analysis of the state of environmental protection in the West Pomeranian province.

Keywords: environmental protection, county, zachodniopomorskie province.

Category of the paper: Research paper.

1. Introduction

The socio-economic development of any country and region is primarily related to the way and volume of production of material goods, population, and natural conditions, that is, the surrounding nature, i.e., the geographic environment (Mazur, 2000). Thus, this development occurs in a specific territory (geographic space with particular climatic conditions, water relations, and other natural resources (fossil resources, soils, forests)). Thus, the geographic (natural) environment includes both inorganic (abiotic) elements, such as the bedrock (lithosphere), surface relief, i.e., natural relief (morphology), waters (hydrosphere), the air layer surrounding the Earth (atmosphere) together with climatic phenomena, and organic (biotic) elements, i.e., the natural world of plants (flora) and animals (fauna). A specific element of the geographic environment is space, i.e., the surface of the Earth with specific and unchanging dimensions - it is the component that connects all natural components (Malachowski, 2007, p. 7). Thus, the geographic environment is a set of all natural factors (nature) found in a given area in which people live and which they use as their skills improve to satisfy their material and other needs, that is, recreational, aesthetic (for example, the beauty of the landscape), creative (for example, literature, poetry, art) and scientific. Thus, it can be said that the geographic environment, like nature surrounding humans, is a necessary and permanent condition for the existence and development of human society. However, it is not primarily original but transformed to varying degrees. The geographic environment also contains anthropogenic elements - houses, settlements, roads, airports, ports, artificial bodies of water, etc., the so-called technosphere (technical environment) (Malachowski, 2007, p. 10).

In economic science, it is essential to understand and describe the relationship between the natural environment and the economy. The economic importance of the environment is indisputable. It is a direct source of energy, some means, and objects of labor and means of consumption, a receiver of production and consumption waste, and determines agricultural, forestry, and fishing production. It also determines the possibilities for the development of transportation, influences human health, and shapes the residential and recreational space necessary for the proper development of the individual and society (Żylicz, 1989).

The relationships between elements of the environment and the changes in these elements themselves are complex. Man is an element of the environment while simultaneously introducing quantitative and qualitative changes in it. The extent of human interference with the natural environment depends mainly on technical and economic possibilities (Bernaciak, 2002).

Due to the intensity of nature's transformation measured by the degree of its saturation with anthropogenic elements, three types of environment are distinguished: natural, transformed (transformed), and artificial.

The concept of environmental protection is interpreted in many ways. In a very general sense, it is activities aimed at preserving or restoring rare, valuable living and inanimate creations of nature and natural resources and ensuring the permanence of their use; it includes, among others, landscape protection (landscape parks and others), reserve protection (reserves, national parks), species protection, nature monuments (Popular Encyclopedia, 1996).

In a broader sense, the depletion of natural resources includes the protection of all natural resources. On the other hand, in the broadest sense, nature conservation is almost synonymous with environmental protection (Mazur, 2004).

According to the PWN Popular Encyclopedia, environmental protection is an activity aimed at protecting all elements of the environment from the adverse impact of human activity and such shaping of human activity that it provides optimal conditions for physical and mental development, also preserving intact natural elements of a natural nature (Popular Encyclopedia, 1996). Nature conservation and environmental protection are two separate though complementary streams. In nature protection, nature itself and its resources are in the foreground, to be protected from destruction, devastation, and irrational management. In contrast, in environmental protection, the protection of humans, their lives and health, and the quality of life came to the fore.

Environmental protection differs from nature conservation in that actions to protect nature can, to some extent, be considered manifestations of altruism. We protect nature for nature's sake, not only for nature's sake, because everyone wants to benefit from nature. Environmental protection is the protection of human beings and their living conditions. Environmental protection is also a necessary condition for the effectiveness of nature (Uminski, 1996). Current efforts to protect the natural environment take place, among other things, on the economic, legal, technical, and organizational levels and use various methods (effective and efficient) to ensure maximum protection of natural elements and their rational use by people (Mayer, 2000).

Economic measures are intended to generate adequate motivation to undertake projects to prevent environmental deterioration and remove existing damage and deformation. The overexploitation of nature's resources by various countries, which do not include costs and inputs in their calculations, has led to a rapid deterioration of the anthroposphere. Some natural resources, primarily water and air, were previously considered free goods both in their inexhaustible abundance and non-deteriorating quality have caused a sharp increase in expenditures for their acquisition. Water and air have thus become economic goods, for the use of which payment is due (Gorczyca, 1976).

Economic instruments for the protection of the natural environment provide an indirect form of influence on economic agents while affecting their financial condition. These instruments are presented as an alternative to directly regulating environmental degradation activities. The purpose of using instruments in the field of environmental policy is to achieve the assumed level of environmental quality or to realize balanced but sustainable socio-economic development (Bernaciak, Gaczek, 1996). The essence of economic and environmental instruments is to influence the price-setting process to consider the costs of environmental pollution when economic agents and consumers make decisions.

2. Characteristics of the study area

In this article, a study was conducted to diagnose the state of environmental protection in the West Pomeranian Voivodeship. Zachodniopomorskie Voivodeship is located in the northwestern part of Poland, by the Baltic Sea and the Szczecin Lagoon. From the west, it borders Germany (with the states of Mecklenburg-Vorpommern and Brandenburg). The total length of the province's borders is 982.9 km, including the western state border with Germany, and the sea border in the north has a similar length of 188.9 km. The province's capital is Szczecin, with a population of nearly 400,000 in 2020 (according to CSO data). The voivodeship covers an area of 22,897 square kilometers, 7.3% of Poland's area (the fifth largest in the country).

The West Pomeranian region has an agricultural and industrial character. The area of agricultural land in 2018 was 1,129.9 thousand hectares (according to the Central Statistical Office), accounting for about 49.3% of the province's total area. The main branches of the economy are agriculture and the food industry. Timber, metal, chemical, and electricity production are also important industries. Also of great importance to the region are the four commercial seaports located within the region: Szczecin, Swinoujscie, Kolobrzeg, and Police, as well as a dozen smaller seaports and fishing harbors (Report, 2019). The entire area of the province is a special economic zone. Numerous investment areas are located in the province, including 19 special economic zones, eight industrial parks, and two science and technology parks. In addition, the region has natural minerals: natural gas, oil, ores of iron, limestone, marls, peat, peat bogs, thermal waters, and brine. The solid development of organic agriculture characterizes the province. Two central geographic-physical regions can be distinguished in the province: South Baltic Coast and Pomeranian Lake District. The voivodeship's climate is moderate, predominately westerly, northwesterly, and northern winds. The abundance of water bodies and a large area of forests determine the high air humidity. The average annual temperature is 9.3°C, and the average annual precipitation of 550-700 mm.

Surface waters occupy about 5.2% of the province's area. In addition to the Szczecin Lagoon and the Kamienski Lagoon, they consist of numerous lakes and a rich river network. Lakes mainly occur in the Lake District: Wałeckie, Choszczno, Insko, Mysliborsk, and Drawskie. Lakes with an area of more than 50 hectares there are 178, and the largest lakes in the province include Dąbie and Miedwie. The more important rivers of the province are Odra (with tributaries: Tywa, Rurzyca, Drawa, Mysia, Plonia, and Ina, as well as rivers flowing directly into the Baltic Sea: Rega, Parsęta, and Wieprza (Report of the Chief Inspectorate for Environmental Protection, 2020).

The essential document defining the directions of the development policy of the West Pomeranian region West Pomeranian Voivodeship and the goals that should be achieved on the horizon until the year 2030 is the Development Strategy of the West Pomeranian Voivodeship until 2030. The vision of the region's development formulated therein aims to achieve the perspective of the year 2030 development goals ensuring a higher quality of life for the region's residents based on the potential of a modern economy. The most critical assets identified in the Strategy assets at the disposal of West Pomerania, and at the same time, the challenges facing the region, including facing the region include demographic changes, socio-public activity, education, blue economy, and tourism. The objectives and tasks of the ecological policy of the West Pomeranian Voivodeship in individual areas of intervention in perspective until 2024 are formulated in the Program for Environmental Protection of the West Pomeranian Voivodeship for 2016-2020 with an outlook until 2024. The main objective of the Program is to strive to improve the state of the environment in the voivodeship, reduce the negative impact of pollution on the environment, as well as to protect and develop the values of the environment and rational management of its resources. The achievement of the above objective will be served by implementing the environmental priorities identified in the document (areas of intervention).

3. Methodology

The following potential diagnostic variables were proposed to measure the quality of the environment in the counties of the West Pomeranian region in the year under study. The selection of variables was made arbitrarily.

X1 - total treated wastewater discharged in dm^3 per km^2,

X2 - total treated wastewater in % of the total,

X3 - population served by treatment plants in % of the total population,

X4 - water consumption for the industry in dm^3 per 1 km^2,

X5 - dust pollution emissions in tons per 1 km^2,

X6 - emission of gaseous pollutants in tons per 1 km^2,

X7 - particulate pollutants retained or neutralized in abatement facilities in % of total pollutants generated; this indicator is expressed as a percentage ratio of the amount of pollution retained to the amount of pollution generated, i.e., retained and emitted,

X8 - gaseous pollutants retained or neutralized in abatement facilities in % of total pollutants generated; this indicator is expressed by the percentage ratio of the amount of pollutant retained to the amount of pollutant generated, i.e., retained and emitted (Environmental Protection, 2020),

X9 - total waste generated during the year in a thousand tons per km^2,
X10 - total waste disposed of during the year in % of total waste,
X11 - legally protected areas in % of total area,
X12 - nature monuments per 1 km^2,
X13 - total municipal and industrial wastewater treatment plants per 1 km^2,
X14 - expenditures on municipal management and environmental protection in PLN per person.

The values of the variables are shown in Table 1.

Table 1.
Potential environmental diagnostic variables in Poviats of West Pomeranian Voivodeship in 2020

	Total wastewater discharged	Wastewater treated together	Population served by wastewater treatment plants	Water consumption for industry	Dust emissions	Gaseous emissions	Particulate pollutants retained or neutralized in reduction facilities	Gaseous pollutants retained or neutralized in reduction facilities	Total waste generated during the year	Total waste disposed of during the year	Total legally protected areas	Natural monuments	Total municipal and industrial wastewater treatment plants l	Expenses for municipal management and environmental protection
	dam^3/km^2	%	%	dam^3/km^2	ton/km^2	ton/km^2	%	%	tys. t/km^2	%	%	per 1 km^2	per 1 km^2	zł/per person
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
Poviat białogardzki	1,65	97,58	76,79	0,68	0,14	66,46	95,44	0,07	0,02	12,56	0,00	0,09	0,01	25,84
Poviat drawski	0,98	88,43	70,15	0,20	0,03	7,79	18,18	0,00	0,00	0,00	0,43	0,14	0,01	31,13
Poviat kołobrzeski	6,26	99,91	86,61	0,56	0,13	119,85	94,83	0,00	0,06	14,51	0,07	0,32	0,02	23,24
Poviat koszaliński	1,14	89,25	55,05	0,11	0,12	5,47	72,47	0,00	0,00	0,00	0,20	0,10	0,02	154,60
Poviat sławieński	1,76	98,90	71,37	0,05	0,01	8,12	52,17	0,00	0,06	5,77	0,14	0,16	0,01	136,11
Poviat szczecinecki	1,31	97,80	77,12	0,64	0,59	204,13	95,30	0,00	0,13	0,04	0,28	0,08	0,01	7,20
Poviat świdwiński	1,15	97,81	67,35	0,54	0,02	10,80	41,03	0,00	0,00	35,29	0,14	0,20	0,02	32,78
Poviat wałecki	1,16	97,49	74,10	0,41	0,06	24,19	82,65	0,00	0,01	1,94	0,52	0,07	0,01	24,62
Poviat m.Koszalin	75,02	100,00	98,72	2,51	1,30	1 663,87	92,49	0,00	0,55	5,46	0,45	0,71	0,01	20,54
Poviat choszczeński	1,01	97,97	74,82	0,07	0,04	9,04	83,78	0,00	0,01	1,79	0,54	0,08	0,02	195,96
Poviat gryficki	2,74	102,26	72,17	0,22	0,02	4,81	14,29	0,00	0,00	0,00	0,00	0,07	0,02	84,68
Poviat myśliborski	1,77	90,28	65,87	0,24	0,06	71,39	97,83	0,00	0,19	3,87	0,44	0,09	0,01	15,75
Poviat pyrzycki	1,31	100,76	72,71	0,09	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,03	0,02	3,56
Poviat stargardzki	2,58	101,75	78,36	0,55	0,10	84,98	81,51	0,00	0,33	0,14	0,08	0,07	0,02	15,88
Poviat łobeski	0,83	98,68	51,83	0,27	0,07	16,33	82,81	0,02	0,00	0,00	0,03	0,02	0,01	107,40

Cont. table 1.

Poviat m.Szczecin	69,92	31,31	14,96	448,90	3,17	3 823,17	98,54	0,06	0,80	20,12	0,06	0,09	0,23	11,42
Poviat gole-niowski	1,81	99,05	67,71	0,38	0,13	21,09	61,40	0,26	0,06	1,10	0,08	0,05	0,01	106,26
Poviat gryfiń-ski	1,31	99,93	64,82	683,25	0,67	3 030,27	99,66	0,44	0,38	39,28	0,25	0,14	0,02	26,88
Poviat kamień ski	2,14	97,98	69,44	0,02	0,00	0,28	0,00	0,00	0,00	0,00	0,10	0,13	0,02	30,51
Poviat policki	3,81	99,85	78,91	262,26	1,20	2 174,10	95,75	0,52	6,95	87,47	0,03	0,01	0,01	119,32
Poviat m.Świn oujście	16,47	68,14	99,84	1,37	4,04	7 338,98	95,75	0,52	0,06	0,00	0,18	0,13	0,04	0,66

Source: own calculations based on statistics from www.stat.gov.pl

Using statistical data for 2020, a matrix of correlation coefficients R was created to identify the final set of diagnostic variables. Two levels of r* values were established:

1. r* > 0.4329, which was calculated based on the formula proposed by S. Bartosiewicz (Bartosiewicz, 1976).

$$r^* = \sqrt{\frac{t_\alpha^2}{t_\alpha^2 + n - 2}} = \sqrt{\frac{2{,}093^2}{2{,}093^2 + 21 - 2}} = 0{,}4329$$

where:

t_α - critical value read from Student's t - distribution tables for n - 2 degrees of freedom and for a predetermined level of significance α, $t_{\alpha=0{,}05, ss=19} = 2{,}093$,

2. r > 0.5, a level often used in taxonomic studies (Nowak,1990).

Table 2 presents the results of the selection of diagnostic variables using Hellwig's method for 2020.

Table 2.

First stage of selection of diagnostic variables for r > 0.4329 for 2020*

	X1	*X2*	*X3*	*X4*	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}
X1	*1,0000*	*0,5916*	*0,1681*	*0,2672*	**0,6114**	0,4471	0,2871	0,0229	0,0588	0,0263	0,1009	0,6330	0,6494	0,2687
X2	*0,5916*	*1,0000*	*0,5736*	*0,3711*	**0,7720**	0,6235	0,2457	0,1426	0,0134	0,0032	0,0489	0,0833	0,9189	0,2315
X3	*0,1681*	*0,5736*	*1,0000*	*0,4383*	0,0400	0,0744	0,0270	0,2025	0,0558	0,0470	0,2167	0,4153	0,7035	0,1336
X_4	0,2672	0,3711	0,4383	1,0000	0,3620	0,4700	0,3314	0,5251	0,3337	0,5788	0,0977	0,0774	0,4752	0,1137
X_5	0,6114	0,7720	0,0400	0,3620	1,0000	0,9473	0,4078	0,5605	0,2069	0,1693	0,0638	0,1263	0,6213	0,2982
X_6	0,4471	0,6235	0,0744	0,4700	**0,9473**	1,0000	0,3972	0,7287	0,2190	0,2504	0,0465	0,0956	0,4512	0,2836
X_7	0,2871	0,2457	0,0270	0,3314	0,4078	0,3972	1,0000	0,3443	0,2382	0,2754	0,2210	0,1396	0,1725	0,0186
X_8	0,0229	0,1426	0,2025	0,5251	**0,5605**	0,7287	0,3443	1,0000	0,5591	0,5916	0,1771	0,1702	0,0119	0,0048
X_9	0,0588	0,0134	0,0558	0,3337	0,2069	0,2190	0,2382	0,5591	1,0000	0,8556	0,1917	0,1336	0,0182	0,2024
X_{10}	0,0263	0,0032	0,0470	0,5788	0,1693	0,2504	0,2754	0,5916	0,8556	1,0000	0,2259	0,0596	0,0790	0,0910
X_{11}	0,1009	0,0489	0,2167	0,0977	0,0638	0,0465	0,2210	0,1771	0,1917	0,2259	1,0000	0,3080	0,2005	0,0451
X_{12}	0,6330	0,0833	0,4153	0,0774	0,1263	0,0956	0,1396	0,1702	0,1336	0,0596	0,3080	1,0000	0,0600	0,2276
X_{13}	0,6494	0,9189	0,7035	0,4752	**0,6213**	0,4512	0,1725	0,0119	0,0182	0,0790	0,2005	0,0600	1,0000	0,1984
X_{14}	0,2687	0,2315	0,1336	0,1137	0,2982	0,2836	0,0186	0,0048	0,2024	0,0910	0,0451	0,2276	0,1984	1,0000
$\sum$	*4,1326*	*4,6195*	*3,0957*	*4,4416*	***5,1869***	*5,0345*	*3,1057*	*4,0415*	*3,0865*	*3,2531*	*1,9437*	*2,5294*	*4,5601*	*2,1172*

Source: own calculations using EXCEL spreadsheet.

Table 2 shows that in the first stage of calculations, the central variable X5 qualified for the study, while the following satellite variables did not qualify: X1; X2; X6; X8; X13.

Table 3.
Second stage of selection of diagnostic variables for r > 0.4329 for 2020*

	X_3	X_4	X_7	X_9	X_{10}	X_{11}	X_{12}	X_{14}
X_3	1	0,43826	0,02701	0,05581	0,04699	0,21666	0,41525	0,13363
X_4	0,43826	1	0,33135	0,33371	**0,57880**	0,09772	0,07737	0,11367
X_7	0,02701	0,33135	1	0,23817	0,2754	0,22100	0,13956	0,01859
X_9	0,05581	0,33371	0,23817	1	**0,85559**	0,19174	0,13361	0,20240
X_{10}	0,04699	0,57880	0,2754	0,85559	1	0,22586	0,05962	0,09097
X_{11}	0,21666	0,09772	0,22100	0,19174	0,22586	1	0,30802	0,04505
X_{12}	0,41525	0,07737	0,13950	0,13361	0,05962	0,30802	1	0,22760
X_{14}	0,13363	0,11367	0,01859	0,20240	0,09097	0,04505	0,22760	1
∑	*2,33363*	*2,97092*	*2,25110*	*3,01104*	***3,13325***	*2,30609*	*2,36105*	*1,83192*

Source: own calculations using EXCEL spreadsheet.

Table 3 shows that in the second stage of calculations the central variable X10 qualified for the study, while the following satellite variables X4, X9 did not qualify. The remaining variables: X3, X7, X11, X12, X14 are isolated variables, since the values of their correlation coefficients are not greater than the r* value (see Table 4).

Table 4.
Isolated variables for r > 0.4329 for 2020*

	X_3	X_7	X_{11}	X_{12}	X_{14}
X_3	1	0,027013	0,216668	0,415251	0,133631
X_7	0,027013	1	0,221006	0,13956	0,018592
X_{11}	0,216668	0,221006	1	0,308023	0,045053
X_{12}	0,415251	0,13956	0,308023	1	0,227602
X_{14}	0,133631	0,018592	0,045053	0,227602	1
∑	*1,792563*	*1,406172*	*1,79075*	*2,090435*	*1,424878*

Source: own calculations using EXCEL spreadsheet.

From the research conducted and the determination of the correlation matrix of variables, it follows that the final set of diagnostic variables will include the following variables:

X3 - population served by treatment plants in % of the total population,
X5 - dust pollution emissions in tons per km^2,
X7 - particulate pollutants retained or neutralized in reduction facilities in % of total pollutants generated,
X10 - total waste disposed of during the year in % of total waste,
X12 - natural monuments per 1 km^2,
X14 - expenditures on municipal management and environmental protection in PLN per person.

4. Discussion and Conclusions

To rank the counties of the West Pomeranian Voivodeship by the state of environmental protection in 2020, a taxonomic measure of development was calculated. According to the stages of determining the taxonomic measure of development, the nature of the diagnostic variables was first determined.

It turned out that in the set of diagnostic variables [X3, X5, X7, X10, X12, X14], which will be the basis for carrying out the classification of poviats of the West Pomeranian region in terms of the state of environmental protection, five stimulants X3, X7, X10, X12, X14, and one destimulant X5 can be distinguished. The destimulant was transformed into a stimulant.

Then all variables (stimulants) were brought to comparability, using two ways of transforming variables:

1) standardization,
2) zeroed unitarization.

These two methods are aimed at comparing the classification results depending on the transformation formula adopted. The normalization formulas provide the normalized values with differentiated variability and, simultaneously, a constant spread for all variables. Classical standardization, on the other hand, results in standardizing the values of all variables in terms of variability measured by the standard deviation, eliminating variability as a basis for differentiating objects (Gatnar, Walesiak, 2004). Standardization of variables was carried out according to a formula using STATISTICA 8.

Using the standardized variables, a synthetic variable () was determined for each county. The values were then normalized to the interval [0,1]). The values of the variable were used to create a ranking of the counties of West Pomeranian Voivodeship in terms of the state of environmental protection and to determine the belonging of the counties to typological groups.

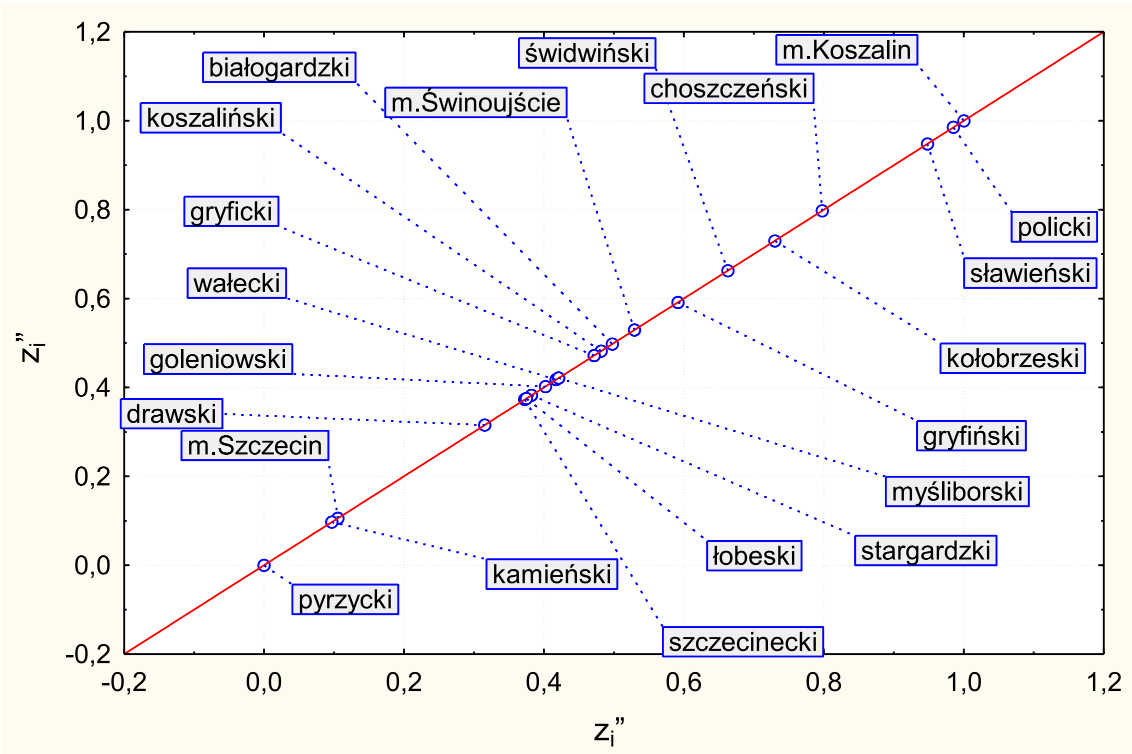

Figure1. Ranking of Poviats of Western Pomeranian Voivodeship regarding the state of environmental protection in 2020 (standardized variables).

Source: own elaboration using tools of STATISTICA 8 package.

The survey shows that the best state of environmental protection in the West Pomeranian Voivodeship was characterized by the poviaty of Sławieński, Choszczeński, Police and the city of Koszalin. In the second typological group were Poviaty: białogardzki, kołobrzeski, koszaliński, świdwiński, gryfiński and Świnoujście. The poor state of environmental protection was characterized by the following poviats: drawski, szczecinecki, wałecki, gryficki, myśliborski, stargardzki, łobeski, goleniowski. The worst state of environmental protection was characterized by the following poviats: pyrzycki, kamienski and the city of Szczecin.

In summary, the West Pomeranian province has average natural resources. Varying pressures on the natural environment characterize it. High differentiation is characterized by indicators occurring in infrastructure. However, with a high degree of sewerage in the province and a relatively small disproportion between the length of the sewerage and water supply networks, the overall assessment of the level of environmental infrastructure is relatively low, which is mainly due to the low level of industrial waste utilization on a national scale.

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