

INTRA-REGIONAL DIFFERENTIATION IN THE ENVIRONMENTAL DIMENSION OF MUNICIPALITIES OF ŚWIĘTOKRZYSKIE VOIVODESHIP IN TERMS OF DEMOGRAPHIC CHANGES IN 2010 AND 2020

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Abstract. The region is a nexus of interaction between the social, economic, and environmental spheres. Demographic potential is a particularly salient factor, especially for peripheral regions (which is how the Świętokrzyskie Voivodeship can be defined in terms of the EU). Transformations in demographic processes and structures exert influence over social, economic, and political aspects, as well as environmental changes. They necessitate the provision of additional transportation services, food, dwelling space, and clothing. The concentration of population and industry in a region has an impact on the environment, particularly with regard to the quality of life of residents and local ecosystems. The concept of independent regional development highlights the environmental factors that influence regional development. It addresses the developmental challenges faced by peripheral regions, incorporates environmental concerns into the development process, and integrates the environmental dimension with the economic and social aspects, particularly in the context of demographic shifts. The environment can be conceptualised as both a development factor and a component of endogenous potential, thereby providing a basis for delineating the process of action. The objective of this article is to evaluate the spatial differentiation of the natural environment of municipalities in relation to demographic changes, employing a synthetic measure. The analysis was conducted at the municipal level, encompassing 102 municipalities within the province of Świętokrzyskie. The data used in this study were sourced from the Central Statistical Office and relate to the years 2010 and 2020. The municipalities of the Świętokrzyskie province exhibit a distinctive character. The analysed areas frequently exhibit a negative migration balance, which has an adverse impact on the development process and the quality of the environment. From the perspective of the influence of demographic trends on economic processes, the ageing of the population represents a highly significant factor. Such shifts do not always have a negative impact on the economy, as they can stimulate demand for new products and services. The synthetic measure of demography exhibited a range of 0.30 to 0.67 in 2010 and 0.29 to 0.69 in 2020. With regard to the synthetic measure of natural environment and ecology in the municipalities of the Świętokrzyskie region, a variation was observed (0.25-0.52 in 2010, 0.30-0.60 in 2020). The natural environment is a key factor influencing the attractiveness and competitiveness of rural municipalities. The demographic potential of the natural environment is an important factor for development. Poland needs to strengthen synergies between green growth, environment and demographic aspects to address environmental and energy challenges and overcome resource shortages.

Keywords: environment, attractiveness, demography, synthetic measure, TOPSIS method.

JEL Classification: Q56, J11

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1. Introduction

In the view of A. Jewtuchowicz (2005), a region is a place of interaction between the social, economic and environmental spheres. Furthermore, it can be conceptualised as a network of ties, interactions and social relations. It constitutes an area of life, economic and social activity, with a history and culture of its own, as well as a distinctive economic and human potential. As H. Pondel (2015) notes, the issue of effective management of natural resources is of paramount importance in light of the region's appeal. The state of resources (in terms of quality and protection) may act as a constraint on the development of the municipality.

In recent years, sustainable development has become one of the most popular ideas defining development at all levels of local government units (community, district, voivodeship). It focuses on environmental issues and resource depletion due to human activity, forming appropriate proportions in the economic, ecological-spatial and social dimensions. Monitoring the effects of the measures taken plays an important role in the process of sustainable development. As Fiedor B. (2001) suggests, issues of sustainable development (the creation of economic development in harmony with ecological requirements and social expectations) are of particular importance in a period of economic crisis (which is currently also an energy crisis), when relations between market participants are clearly disrupted. C. Garcia, P. A. López-Jiménez, M. Pérez-Sánchez, and R. Sanchis (2024) observe that this approach facilitates the more efficient utilisation of resources in accordance with social demand.

As A. Kasztelan (2010) notes, a strategic analysis of the resources and potential of a given region – including environmental, demographic, infrastructural, and economic factors – can identify opportunities that can ensure a sustainable competitive position (or attractiveness) in the market for offered products and services.

The demographic potential is a particularly important factor, especially for peripheral regions (which is the case of Świętokrzyskie Voivodeship in relation to the EU), and needs to be analysed in order to determine its socio-economic development and environmental impact. Changes in demographic processes and structures affect social, economic and political aspects or environmental changes. An understanding of the demographic potential (demographic attractiveness) of a region and the factors influencing it, as presented by Gwiazdzińska-Goraj M., Pawlewicz K., Jezierska-Thöle A. (2020), is a crucial element in the formulation of regional policy. The growth of the population leads to an increase in demand for goods and services, which has

a detrimental impact on the environment (resources) and results in an expansion of municipal and industrial waste.

The objective of this article is to evaluate the spatial differentiation of the natural environment of municipalities in relation to demographic changes, utilising a synthetic measure. The analysis was conducted on a system comprising 102 municipalities within the Świętokrzyskie Voivodeship. The source material comprised data from the Central Statistical Office for the years 2010 and 2020. This enabled the authors to address the question of which local differences can be identified in the context of the relations between the natural environment, ecology and demographic changes. The authors identify the changes that have occurred at the level of the phenomenon under study and observe the migration of municipalities among different typological groups. Furthermore, the authors consider the changes occurring in the municipal economy.

2. Literature Review

A. Kasztelan (2015) highlights the necessity for Poland to enhance the interconnectivity between intelligent and environmentally-conscious growth strategies, integrating environmental considerations with demographic factors, in order to effectively address the challenges posed by climate change, environmental degradation, and energy efficiency, as well as the growing scarcity of resources. D'Amato D., Korhonen J. (2021) define the green economy as a closed-loop economy. This signifies the necessity to establish an economic system founded upon renewable processes that foster biodiversity, thereby benefiting both current and future generations.

As J. T. Liberty and others (2024) describe, climate change, biodiversity loss, pollution and resource depletion present a significant threat to the stability of ecosystems and the well-being of people living in regions. Furthermore, disparities in access to resources and opportunities intensify social inequalities, perpetuating cycles of poverty and marginalisation, which in turn have an impact on the state of the environment. In their 2019 study, Khoshnava, S.M. and colleagues highlight the green economy as a response to global challenges in the environmental, economic, and social realms. They posit that it represents a viable path of economic development, contingent upon the integration of environmental constraints and criteria regarding the availability of environmental resources and services. Similarly, E. Loiseau and colleagues (2016) indicate that it is a method of acquiring and utilising resources. As Elimam (2017) asserts, this approach offers advantages for the regional economy. It facilitates more efficient utilisation of resources, curtails the misapplication of scarce resources, and

mitigates environmental contamination. These outcomes collectively promote the ecological advancement of the region and enhance the quality of life for residents.

From an economic standpoint, it is crucial to comprehend and delineate the interconnections between the natural environment and the economy. The environment serves as a primary source of energy, a conduit for certain forms of labor, a conduit for consumption, and a receptor for both production and consumption waste. Furthermore, it influences agricultural, forestry and fishing production, the potential for transportation development, and has an impact on human health (Winpenny, 1995). The deterioration of the environment has highlighted the necessity for changes in economic policy with regard to environmental management. S. Estella Kim, H. Kim, and Y. Chae (2014) argue that green growth is a necessity in light of the region's current environmental, energy and resource depletion crises. It is imperative that the aforementioned approach be made more environmentally and economically sustainable.

The concept of independent regional development highlights the environmental factors that influence such development. It addresses the developmental challenges faced by peripheral regions, the incorporation of environmental considerations into the development process, and the integration of environmental concerns with economic and social factors, particularly in the context of demographic shifts (Wróblewski, 2012). The natural environment, as both a development factor and a component of endogenous potential, can serve as the foundation for delineating the process of action (Gałązka, 2011). It is important to note that, as Kasztelan (2010) asserts, the optimal utilisation of environmental potential will result in augmented economic effects, enhanced environmental quality, the advancement of social objectives and an improved quality of life. The utilisation of natural resources constitutes an indispensable input for the advancement of economic and social development. The unsustainable utilisation of these resources is a primary driver of environmental degradation and resource depletion, which in turn poses a significant threat to the well-being of humanity and the natural environment. As Albert Merino-Saum (2018) and others have observed, the concept of a green economy is an instrument designed to facilitate sustainable resource management.

The demographic structure, comprising age structure, gender structure and population reproduction capacity, constitutes one of the fundamental characteristics of the population resources of a given society. This is fundamental to the social categories of the individual in question. The consequences of this demographic structure affect various aspects of economic life,

including the level of budget revenues. Heffner K. and Marszał T. (2006) highlight the importance of considering the demographic potential, encompassing factors such as population size, density, age and gender structure, in the context of ongoing fertility decline, population ageing and increasing population mobility or growing infrastructural needs. They posit that this potential plays a significant role in influencing both the development process and changes in the natural environment. As demonstrated by A. Rosner's research, there is a significant correlation between population processes, including natural population movement and migration, and the level of socio-economic development. In this regard, there is a tendency for the observed disparity to deepen. For example, areas with low population density (peripheral areas) often experience further depopulation. The demographic processes contribute to an increase in the distance between the growth centres and other areas. The findings of Myrdal's cumulative causality model are validated, indicating a profound intensification of regional development disparities and unfavourable demographic shifts in certain regions. These transformations are challenging to reverse and constitute a significant impediment to socio-economic advancement.

The development of industrial production, agricultural production, transport, and the depletion of natural resources (often due to unsustainable environmental management) lead to significant environmental disruption and the formation of unfavourable, often irreversible changes. On the one hand, the environment provides the necessary raw materials, for example, for production activities, and on the other hand, it is a recipient of pollution. As E. Mazur-Wierzbicka (2013) observes, demographic shifts impact the region's natural capital, climate change, water and air pollution, land surface degradation, overexploitation of natural resources, accumulation of waste, including dangerous materials, and biodiversity reduction. With demographic growth comes changes in the structure of production and consumption. They are harmful to the environment, on the one hand, due to the increased use of natural resources, and on the other hand, due to environmental pollution (e.g., waste, emissions, wastewater associated with production activities, post-consumer waste).

3. Material and Method

A synthetic measure based on the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) method is employed to assess environmental variation in accordance with demographic changes in the municipalities of the Świętokrzyskie Voivodeship. The research process conducted in the following stages:

1. Selection of variables that describe the phenomenon (objects) under study. The diagnostic variables selected for the study include environmental, economic, social, and infrastructural resources that are used in economic and social relations and are interdependent. They influence qualitative and quantitative changes in the local economy and the relationship between the state of the environment and demographic changes. The choice of variables was mainly determined by the availability of data from the municipal system (at the NUTS 5 level).

The elimination of quasi-constant variables was conducted using the coefficient of variation of characteristics (with a cutoff value of 0.10) (Młodak, 2006), as well as the level of correlation of variables (according to the inverse correlation matrix method) (Malina, 2004; Wysocki, 2010).

2. The direction of preference of the variables in relation to the main criterion under consideration was determined.

The identification of the characteristics of the variables is based on statistical and factual evidence. The transformation of the values of the variables is conducted in accordance with the method of zeroed unitisation. The variables are divided into two categories: stimulants and disincentives (Grabiński, Wydymus, Zeliaś, 1989; Kukuła, 2000; Grabiński, 1985).

3. The weights assigned to the selected variables were determined through the application of statistical procedures in accordance with the CRITIC (Criteria Importance Through Intercriteria Correlation) method (Wu, Zhen, Zhang, 2020; Yin, Wang, Wang, Wang, Wang, Chang, 2023).

4. In order to evaluate the individual objects, a synthetic measure was calculated using the Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) method.

In accordance with the adopted methodology, the Euclidean distances of individual objects from the pattern (=1) and the anti-pattern (= 0) were determined. The synthetic measure according to the TOPSIS method was calculated for individual units using the following formula (Wojcik-Leń, Len, Mika, Kryszk, Kotlarz, 2019):

$$q_i = \frac{d_i^-}{d_i^- + d_i^+},$$

where $0 \leq q_i \leq 1, i = 1, 2, \dots, n;$ (1)

where: $q_i \in [0; 1]; d_i^-$ means the distance of the object from the anti-pattern (from 0), d_i^+ means the distance of the object from the benchmark (from 1). A higher value of the measure is indicative of a superior situation for the individual in the area under study (Bieniasz, Golas, Luczak, 2013).

5. In the final stage of the process, the objects were classified into typological groups based on their environmental and ecological levels. The mean and standard deviation for the value of the synthetic measure were employed as threshold values. The correlation coefficient (Pearson) was subjected to evaluation. Additionally, a bag chart for the synthetic measure was presented, and a correlation and concentration coefficient analysis was conducted (Zelias & Malina, 1997).

4. Results and Discussion

The current challenges to environmental sustainability have been triggered by two key factors: the tremendous increase in the exploitation of natural resources and climate change (Kuang, Liang, Zhao, 2023). Given a profound grasp of the ramifications of human-induced environmental degradation and the profound constraints imposed by environmental pollution on economic and social advancement, the imperative of green development is becoming increasingly evident. The proposal is to reduce energy consumption and waste generation in the production process, thereby achieving a mutually beneficial outcome between economic development and resource conservation (Sun, Tang, Dou, Wang, 2024).

The synthetic measure of the natural environment and ecology in the municipalities of the Świętokrzyskie Voivodeship has demonstrated a differentiated trend (0.25-0.52 in 2010, 0.30-0.60 in 2020). An increase in the value of the measure of the unit indicates an improvement in the situation of the studied unit in comparison to all other objects. Conversely, a decrease in the value of the measure of the unit indicates a deterioration in the situation of the studied unit. The differentiation between municipalities is indicated by measures of variability, including the coefficient of variation, measures of central tendency, and the Gini concentration measure (0.09-0.10). Figure 1 illustrates the spatial differentiation of municipalities within the primary criterion of environmental and ecological factors. The function of the region, whether industrial, tourist, agricultural, residential or service-oriented, has been identified as a significant factor influencing differentiation.

The synthetic measure of demographics exhibited a range of 0.30 to 0.67 in 2010 and 0.29 to 0.69 in 2020. The differentiation between provinces is indicated by measures of variation (coefficient of variation: 18.18-17.41, spread 0.37-0.40) and measures of central tendency (mean 0.44-0.46). The decline in the Gini coefficient (from 0.12 to 0.11) signifies a reduction in concentration and a narrowing of the differentiation between individuals.

Green growth is a key perspective of economic growth measured by the generation of income

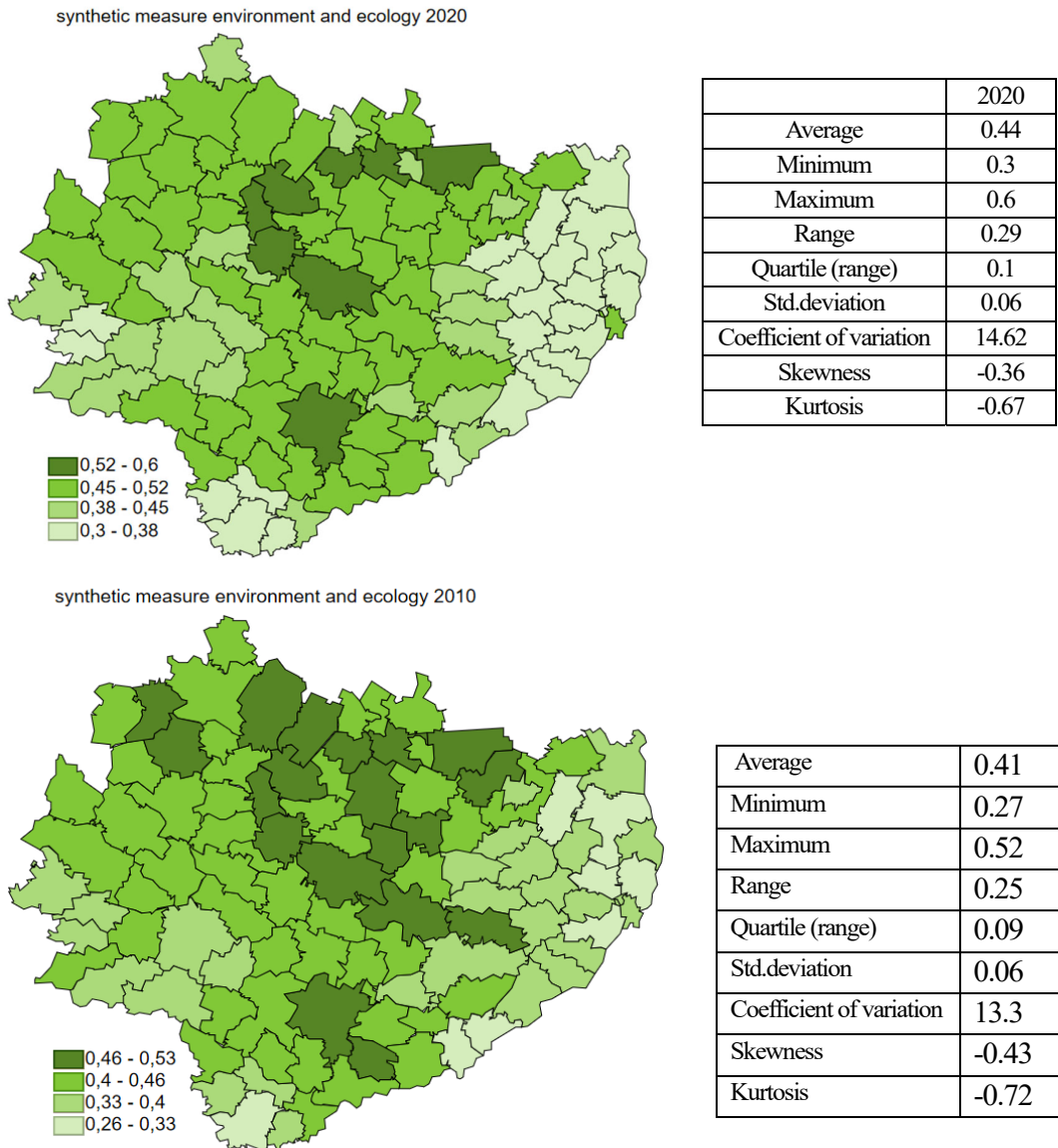


Figure 1. Spatial changes in the synthetic indicator of the natural environment and ecology of municipalities in the Świętokrzyskie Voivodeship in 2010 and 2020

Source: authors' research based on data from the Statistics Poland

from the consumption of natural resources and the undesirable production of environmental outcomes. Environmental degradation has become one of the main problems of regions (Gu, Shen, Zhong, Wu, Rahim, 2023; Rutkowska, Popławski 2017). The state of the environment in the ranking of municipalities was due to natural conditions, as well as the processes of urbanisation or industrialisation (Table 1).

Figure 2 presents the Pearson correlation coefficient between the value of the synthetic measure (year-on-year) of the environment and ecology and demographics of municipalities, as well as outlier units. It also indicates the level of Pearson's linear correlation. The bag chart indicates groups of municipalities that are statistically similar (including

outliers, whose graphical shape in subsequent years indicates their differentiation).

An undeniable determinant of socio-economic development and quality of life is the environment and the resources that underpin economic activity and the integrity of societies. The environment is both the basis for development in the broadest sense and an obstacle due to resource depletion. The limitation of environmental resources, juxtaposed with the limitlessness of human needs, necessitates the rational management of its resources (Kryk, 2015). Efficient use of natural resources is a necessary condition for sustainable development, which encompasses environmental, economic and social dimensions (Wen, Zhang, 2024). Sustainable development (or green economy) issues will have a huge impact

Table 1
Selected characteristics of groups of municipalities according to the synthetic index of environment and ecology in the municipalities of the Świętokrzyskie Voivodeship in Poland in 2010 and 2020

Number of units in the group	2010				2020			
	19	48	27	8	8	50	21	23
Q environment and ecology	0.48	0.44	0.36	0.32	0.55	0.48	0.42	0.35
Urban and rural cleansing	11.99	18.49	6.49	21.16	17.45	13.54	14.35	3.48
Maintenance of greenery in cities and municipalities	11.14	2.71	11.14	1.33	15.36	5.41	7.58	3.32
Protection of atmospheric air and climate	4.66	0.54	0.97	0	66.99	41.66	10.88	63.47
Wastewater management and water protection	276.51	92.52	14.76	42.39	116.14	113.24	41.48	17.27
Municipal waste management	2.44	7.09	3.78	6.8	157.32	138.93	128.54	77.57
Q demography	0.46	0.45	0.42	0.41	0.5	0.46	0.46	0.43
Migration balance	0.69	-0.35	-1.72	-2.2	0.87	-1.63	-1.77	-1.62
Population density	178.42	122.48	154.27	91.29	307.78	85.78	231.49	65.68
Change in population per 1,000 inhabitants	18.38	11.35	5.97	10.79	-5.09	-7.34	-8.22	-7.64

Source: authors' research based on data from the Statistics Poland

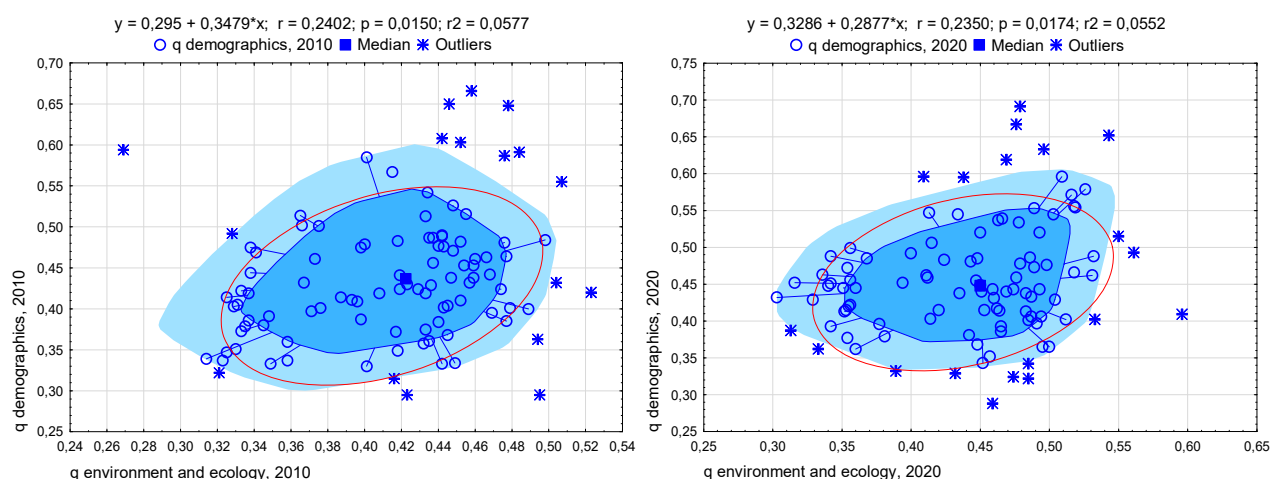


Figure 2. Variation in the relationship between synthetic indicator demographics and environment and ecology in 2010 and 2020

Source: authors' research based on data from the Statistics Poland

on all aspects of human life in economic, social, environmental and political terms. The processes of structural transformation of economies are accompanied by an increase in the unevenness of their development. The green economy and sustainable development both seek to enhance the quality of life by ensuring the fulfilment of human needs and safeguarding the environment, natural resources, and the integrity of society (Tapia-Fonllem, Corral-Verdugo, Fraijo-Sing, 2017). Consequently, local authorities should prioritise social responsibility and the advancement of human capital to foster societal development.

The municipalities of the Świętokrzyskie Voivodeship exhibit a notable degree of spatial diversity, encompassing a range of characteristics pertaining to their degree of development, demographic potential, quality of life, and natural environment. This differentiation can be attributed to a number of factors, including

demographic, natural, historical, and socio-economic development processes. Table 2 presents the value of the measure of correlation (Pearson's linear) between the synthetic measure of demography, environment and ecology, selected demographic variables and pro-environmental spending.

The municipalities of the Świętokrzyskie Voivodeship (as a peripheral area of the EU) have their own peculiarities. In the analysed rural areas in recent years (2004-2014), a negative migration balance was often recorded, and an imbalance in the age structure was observed, which is a consequence of the acceleration of the population ageing process, which directly affects the ability to generate national income. From the perspective of the influence of demographic shifts on economic activity, the ageing of society represents a pivotal consideration. The impact on the economy is not uniformly negative. In fact, it can stimulate demand for new products and services tailored

Table 2

Pearson's linear correlation between the synthetic indicator of demography, environment and ecology, and selected demographic variables and environmental expenditures for 2010 and 2020

	Migration balance	Migration balance	Migration balance	Migration balance	Migration balance	Migration balance	Migration balance	Migration balance	Migration balance	Migration balance	Migration balance
2010											
Migration balance	1.00	-0.23	0.34	0.34	-0.36	0.06	0.06	0.14	-0.15	0.23	
Population density	-0.23	1.00	-0.01	0.24	0.15	0.04	-0.02	-0.08	0.22	0.07	
Change in population per 1,000 inhabitants	0.34	-0.01	1.00	0.33	0.08	0.12	0.06	0.15	0.16	0.23	
Q demography	0.34	0.24	0.33	1.00	-0.06	-0.05	-0.02	0.04	0.01	0.24	
Urban and rural cleansing	-0.36	0.15	0.08	-0.06	1.00	-0.03	-0.02	-0.04	-0.04	-0.02	
Maintenance of greenery in cities and municipalities	0.06	0.04	0.12	-0.05	-0.03	1.00	0.00	0.25	0.00	0.02	
Protection of atmospheric air and climate	0.06	-0.02	0.06	-0.02	-0.02	0.00	1.00	-0.03	-0.05	0.10	
Wastewater management and water protection	0.14	-0.08	0.15	0.04	-0.04	0.25	-0.03	1.00	-0.04	0.28	
Municipal waste management	-0.15	0.22	0.16	0.01	-0.04	0.00	-0.05	-0.04	1.00	0.03	
Q environment and ecology	0.23	0.07	0.23	0.24	-0.02	0.02	0.10	0.28	0.03	1.00	
2020											
Migration balance	1.00	-0.10	0.70	0.45	-0.28	0.03	0.00	-0.07	-0.04	0.14	
Population density	-0.10	1.00	-0.12	0.00	0.28	0.25	-0.10	-0.09	0.23	0.10	
Change in population per 1,000 inhabitants	0.70	-0.12	1.00	0.66	-0.11	0.01	0.10	0.02	-0.12	0.12	
Q demography	0.45	0.00	0.66	1.00	-0.05	0.01	0.16	-0.03	-0.11	0.23	
Urban and rural cleansing	-0.28	0.28	-0.11	-0.05	1.00	0.32	-0.12	-0.04	0.25	0.17	
Maintenance of greenery in cities and municipalities	0.03	0.25	0.01	0.01	0.32	1.00	-0.03	-0.01	0.20	0.16	
Protection of atmospheric air and climate	0.00	-0.10	0.10	0.16	-0.12	-0.03	1.00	-0.07	-0.17	0.03	
Wastewater management and water protection	-0.07	-0.09	0.02	-0.03	-0.04	-0.01	-0.07	1.00	0.14	0.29	
Municipal waste management	-0.04	0.23	-0.12	-0.11	0.25	0.20	-0.17	0.14	1.00	0.45	
Q environment and ecology	0.14	0.10	0.12	0.23	0.17	0.16	0.03	0.29	0.45	1.00	

Marked correlation coefficients are significant with $p < .05000$; $N=102$

Source: authors' research based on data from the Statistics Poland

to the elderly (Kalicki, Kiniorska, Kuształ, Wrońska-Kiczor, 2018).

From an economic perspective, it is important to understand the relationship between the natural environment and the economy. The environment is a source of energy, means and objects of labour and consumption. It also serves as a sink for production and consumption waste, determines the conditions for agriculture, forestry and fisheries, and affects human health (Winpenny, 1995). The necessity to consider endogenous specificity potential has been prompted by alterations in the appeal of municipalities. This is in line with the general trend of decentralisation of public competences and the empowerment of the local level. The natural environment plays a pivotal role in determining the appeal and competitiveness of rural municipalities. The most significant resources and assets of a municipality are forests and legally protected areas, which are frequently associated with the profitability of the location (Bartkowiak, Ossowska, 2010).

5. Conclusions

The Świętokrzyskie communities are differentiated by the level of social, economic and environmental

attractiveness and therefore develop unevenly. The natural environment and demographic potential are an important factor of development, which is combined with socio-economic elements in such a way that their development depends on the sustainable use of natural resources. The assessment of the natural environment and demographic potential of municipalities represents a challenging undertaking. It necessitates the consideration of numerous variables, the selection of which can have a considerable impact on the outcomes produced. The results obtained can serve as a valuable source of information for the authorities, highlighting the disparities between units. They point to new areas of research that take into account the new interrelationships of the areas under study (demography, ecology) with entrepreneurship, infrastructure, finance, the construction of a synthetic indicator based on a different method, the assessment of the direction and strength of the impact of outlier variables on the main criterion, or the dynamic analysis of the phenomenon. An additional value of the article is the analysis of the relationship between the natural environment and ecology and the demographic potential of the municipalities of the Świętokrzyskie Voivodeship.

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