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USE OF A MULTIDIMENSIONAL COMPARATIVE ANALYSIS TO EVALUATE A SYNTHETIC INDICATOR MEASURING ENVIRONMENTAL MANAGEMENT IN RURAL AREAS IN POLAND

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ABSTRACT: The main objective of this study has been to measure and evaluate changes in the values of metrics applied to environmental management systems implemented in rural areas in the years 2010 and 2022. The study included three provinces in Poland representing different socio-economic development classes. Two strategic research groups were distinguished within the provinces: rural municipalities and rural areas in urban-rural municipalities. With the Perkal method, a synthetic indicator was constructed to measure environmental performance in rural areas. The Pearson correlation coefficient was applied, leading to the results which substantiated the conclusion that the highest improvement of the environmental management indicator value was achieved in the province at the highest socio-economic development level, even though the sub-indicators did not improve between 2010 and 2022 in all the analysed groups. The management of the environment is a task mostly delegated to local governments. Proposing an environmental monitoring method can support making decisions at the level of local governments as regards directions in the management of the environment in a given area because the synthetic indicator created in this study comprises only these elements that can be moulded by actions undertaken by local governments.

KEYWORDS: environmental management, rural areas, synthetic indicator

Introduction

Following the political and economic transition of Poland in 1989, the Polish countryside has become a more attractive place of living. Meanwhile, there have been profound changes in agriculture, which today manifests its multifunctional character. Nowadays, over 60% of inhabitants of Polish villages have no connection with farmland and agriculture. Farmers are no longer the prevalent group of residents in the countryside (Halamska, 2017), and only about 10% of the rural population derive all their income from agriculture (Wilkin, 2011). There are now villages where all farming has been abandoned, and the number of inhabitants employed in agriculture, as well as the total acreage of farmland, have decreased in most Polish villages. These changes have led to greater differentiation in factors that affect the environment in rural areas.

As some urban dwellers have moved to the countryside, new social practices and a new way of evaluating the natural environment have diffused there (Osiniak et al., 1993; Górnicki, 2012). Rural society has reached this level of awareness at which problems of shaping the environment in rural areas have become as important as economic and social issues, or at least acknowledged (Witkowska-Dąbrowska, 2022). The diversity of rural society should be expanded to include differences caused by the different levels of economic development and the administrative division into rural and urban-rural municipalities.

Considering the above background, the following research questions were posed:

- Are there differences in the value of the synthetic environmental management indicator among the Polish provinces falling into different development classes?
- Was there any improvement in the value of the synthetic environmental management indicator and sub-indicators observed in the year 2022 relative to the base year 2010?

Factors shaping the environment in rural areas

„Any activities in the rural environment should be connected to the broadly understood problems of the rural area, i.e. the land under buildings, including all farmsteads, farmland under agricultural crops, sports facilities as well as all areas used for recreational purposes, and the land under all infrastructure" (Biernacka, 2009; Chilczuk, 1973).

The rural environment, in addition to farmland, includes elements of nature such as rivers, lakes, other water bodies, forests, and ecological sites. Noteworthy, as the changes in rural areas have been progressing since the political and economic transition of Poland, the factors that influence the natural environment have changed, too, and so has the extent of their impact. There are articles in the subject literature on sustainable development of rural areas providing examples of sets of indicators to measure thereof (Czudec et al., 2018), although Śleszyński (2017) suggests that such studies should be carried out on the smallest units of administrative division. He emphasises that this approach has been employed in the European Union for many years but has not yet found many proponents in Poland. To justify the need for research on rural areas, it should be asserted firmly that their development must not proceed at the expense of the environment (especially the natural habitats). It should respect frugal production and consumption while taking into account future ecological consequences of the decisions made today. Preservation of the existing natural resources and a good state of an unpolluted environment are the fundamental requisites for sustainable development and improvement of the quality of the environment in which local populations live (Ziółkowski, 2015). The importance of resources in rural areas for the whole society and the local community has stimulated their widespread research (Ahmed & Rahman, 2000; Chen et al., 2021).

The Common Agricultural Policy strategic plan for 2023-2027 supports the sustainable development of rural areas, friendly to climate and the natural environment, protecting water, soil and air, as well as the diversity of nature (Pagnon & Midler, 2022). Modest environmental protection infrastructure in rural areas, often very basic or even non-existent, remains a challenge. It leads to water pollution, both freshwater resources (wells, springs, rivers, groundwater, and even rainwater catchment basin) and coastal waters along beaches and surrounding reefs and lagoons, which are important areas for tourism, recreation and fisheries.

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Among the most important environmental components and factors influencing the state of the natural environment, the following are worth mentioning: natural capital, volumes of emissions to the environment, the environmental protection infrastructure available, and the impact produced by agriculture. Considering the above information, the selected problem areas associated with the environment in rural areas have been characterised, in addition to which indicators have been designed for their evaluation at the level of a rural municipality and rural areas in urban-rural municipalities.

Volume and consumption of natural capital

Natural capital encompasses stocks of renewable and non-renewable resources. Continuous exploitation of the Earth's resources can lead to irreparable losses of natural capital. The natural capital indicators describe the state of environmental resources, their consumption, and spatial planning, which are very important in rural areas that are abundant in natural resources. An example of an indicator related to natural resources, the value of which depends not only on the natural qualities of an area but also, and predominantly so, on the environmental policy conducted by a given municipality, is the annual change in the total number of trees and shrubs in rural areas. Formerly, trees and shrubs were seen as providing animals and people with shade from the sun, even though – same as today – they also regulated water relationships, thus contributing to the creation of appropriate climate and affecting volumes of crop yields. Currently, besides the roles mentioned above, trees and shrubs are attributed to functions such as purifying air and soil or shaping the landscape. They also influence people's well-being and create an aesthetic quality of the surroundings. Nowadays, the countryside, urbanised to a large extent, witnesses the emergence of needs similar to ones verbalised in cities, that is trees are seen to contribute to the regulation of ambient temperature, shelter for wild animals, a site for relaxation by people, and preservation of biodiversity (Sutkowska, 2006; Huseynov, 2011; Małuszyńska et al., 2018,), and local communities point to the presence of trees and shrubs as a very important metric in the valuation of the environment (Śleszyński, 2017). Recapitulating, big trees especially play a number of roles: climate-shaping, anti-erosion, protection of water and soil resources, biocenotic, sanitary, technical, social and economic ones. Meanwhile, it needs to be underlined that trees in villages live longer and grow faster than in towns. Care for the preservation of the so-called 'pro-ecological areas', which stems from the obligation to make villages greener, entails the maintenance of tree assemblages and hedges. In the face of intensifying climate change and changes in local climates, the planting of new trees carried out on a regular basis will contribute in the future to the reduction of unfavourable changes, especially at a local scale.

Environmental quality of life of village dwellers

Adequate quality of life is an aim of sustainable development and a priority in the European Union's activities. Quality of life is not easy to define unequivocally, and for decades in the past, it used to be associated solely with the economic level of life. It was not until the 1960s that the then developing social currents and social changes led to the inclusion of the so-called 'new quality of life' to the general concept. Its proponents 'opposed to the economic development orientated exclusively to an increase in consumption, which cause damage to the natural environment and social bonds' (Petelewicz, 2016; Rokicka, 1998). Many scholars have made efforts to define it. Kryk (2015) purports that the ecological crisis has made people aware of the scale of threats to the standard of living (objective quality of life) and the subjective quality of life. For this reason, attention is now paid to environmental protection when evaluating the quality of life. In 2014, the European Environment Agency (EEA) issued a publication titled Quality of Life and the Environment (2014). In it, attention is drawn to the behaviour of residents, starting with the local community. Local residents ought to be given a choice of behaviour and be ensured that all people have equal access to infrastructure at an affordable price as far as possible.

One of the elements of the linear environmental protection infrastructure, which contributes to the protection of climate, is a gas pipeline network. Providing people with a gas pipeline installation next to waterworks and a sewage system lays the foundation for the growth of entrepreneurship and

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the improvement of the local residents quality of life. Considering the multifunctional development of the countryside, together with the growing role of its residential function, it is crucial to provide villages with energy infrastructure. Natural gas is a primary source of energy, and it is much more eco-friendly than coal or heating oil. The CO_2 emission from burning natural gas is 30% lower than from heating oil and 50% lower than from coal burning. Natural gas can also be an alternative to unstable renewable energy sources, and can therefore act as a flexible source of energy to supplement the energy generated from RES (Piskowska-Wasiak, 2018; Mohammad et al., 2021; Bednarek et al., 2023). In Poland, the share of natural gas in all energy carriers is barely 13%, which is half the percentage achieved in the EU states on average. Here, the so-called smart gas grid is worth mentioning. Although still lacking a well-grounded and broadly accepted definition, a smart gas grid is supposed to enable the use of gases with different compositions (biogas, biomethane, natural gas with an admixture of water) in pipelines. This solution appears all the more important given the new guidelines issued by the European Union, which recommends lower consumption of fossil fuels, including gas. According to Dzirba (2012), Mukherjee et al. (2020) and Ribeiro and Rode (2019), the qualitative and quantitative development of the gas network in Poland is unavoidable. It is emphasised that a gas grid may also be used as an energy storage facility in the future.

Emissions of pollutants to the environment

Closure of landfills and reduced consumption of harmful chemicals or other hazardous materials will have some influence on the quality of water. It is essential to reduce amounts of untreated sewage and wastewater while increasing amounts of recycled materials and their safe use globally. According to Article 5(2) of Directive (1991) Poland is expected to put into effect certain obligations imposed on wastewater treatment plants, where higher levels of biogenic substances will have to be removed from treated wastewater in all municipal WTPs in urban agglomerations with more than 10,000 RLM. Another important consideration is that the whole territory of Poland, due to its location in 99.7% of the Baltic Sea catchment, has been designated as a sensitive area, that is, the area in which less nitrogen, phosphorus and biodegradable pollutants should be discharged into water bodies (Ministerstwo Infrastruktury, 2017). Excessive quantities of discharged biogenic substances intensify the eutrophication of water bodies and are particularly harmful to stagnant waters and the Baltic Sea, which is an internal sea. This has been turned into a legal regulation in the National Programme for Municipal Wastewater Treatment, but only for WTPs serving urban agglomerations. Noteworthy, more efficient removal of biogenic substances is possible through the optimisation of a technological system (Wałęga et al., 2010; Tomczykowska et al., 2009). Small, domestic wastewater treatment installations in rural areas are not often designed to remove nitrogen and phosphorus from wastewater. If such domestic wastewater treatment facilities are located outside any agglomeration, and sewage and wastewater from own households or farmsteads are discharged into the land that is owned by the person disposing of these pollutants, the reduction of pollutants in wastewater achieved in such wastewater treatment facilities should be at least 20% for BOD5 and at least 50% for total suspended solids. Unfortunately, the Water Law allows one to discharge 5m3 of wastewater from one's own household or farm without a permit to the land they own. Wastewater treatment plants of such capacity are not installations that might considerably affect the environment and, therefore, are not subject to an environmental impact assessment, nor do they require a water law permit or a building permit. Another consequence is the lack of obligation to run control tests of treated wastewater. In a situation where nearly 40% of the population in the countryside uses wastewater treatment facilities, it is worth focusing on the quality of discharged wastewater.

Access to environmental protection infrastructure

The volume of emissions to the environment, discussed above, depends on several factors, including the supply of adequate infrastructure. It is necessary to raise the contribution of local communities to the improvement of water management and sanitation infrastructure to ensure access to adequate and decent sanitary and hygienic amenities for all residents. While 85% of rural inhabitants

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have access to waterworks, less than 40% live in households connected to a sewage system (although this percentage is increasing rapidly), and less than 23% have access to the gas network. Over the past three decades, the focus has been on the development of waterworks and sewage systems. This has been supported by the availability of public funds to finance investments in this area (Pilarska, 2014). Obviously, networked sewage infrastructure is not indispensable in all rural areas. Wherever settlements are dispersed, it can be replaced by domestic wastewater treatment systems. However, when denser housing estates, typical of towns, sprawl over the countryside, a need arises to develop linear water and sewage systems. Kłos (2013) concludes that despite the insufficient number of sewers in the countryside, it should be highlighted that the supply of such infrastructure in Polish villages has improved by 212% since the year 2000. The expansion of sewage systems is significant when plans are drawn to develop tourism or business in rural areas. Access to such infrastructure also limits the illegal practice of discharging household sewage onto arable fields.

Expenditure on environmental protection from municipal budgets

Considering the ever-accelerating pace of climate change or dangerous weather events, eco-zealots suggest that the year 2030 would have to mark the ultimate energy transformation of Europe, regardless of potential economic and social costs. More moderate proponents of air and climate protection see that year as just a presumed deadline, which should not be treated as an absolute one. They recommend less radical and more sustainable solutions, planned over longer periods of time, with the aim of reconciling the need to protect our planet's climate and to maintain the social security and development of its inhabitants (Wolska, 2010; Ostachowski, 2021). Ostachowski (2021) describes difficulties in the implementation of local developments helping to protect the quality of air and climate, using a case study of small rural and urban-rural municipalities. The most serious obstacles are dispersed housing resources and limited incomes of local residents. Another acute problem is that in some municipalities people have no access to natural gas, without which rapid transformation of the heating systems in Poland, which at the moment are largely responsible for emissions of particulate matter and about 70 million tons of CO_2 annually, will prove to be difficult as well. This author claims that the central authorities should make every effort to recognise the barriers hindering local government investments serving to protect air and climate.

Impact of agriculture on the environment

Poland and Romania remain the EU member states with the highest number of farms and the highest employment in agriculture. The agricultural census demonstrated that there were 1,317 thousand farms in Poland in 2020, including 26 thousand with an area of up to 1 ha, compared to 1,509 thousand farms in 2010, of which 25 thousand had less than 1 ha of total agricultural land. Over the decade 2010-2020, the number of the smallest farms with up to 1 ha of total agricultural land increased (by ca. 3%), the same as the number of the largest farms, with total agricultural land of over 20 ha. The highest increase occurred in the number of farms with 20 to 100 ha of total agricultural land (an increase of over 5%) (GUS, 2021).

The new Common Agricultural Policy launched in 2023 envisages that good agricultural practice standards respecting environmental protection will cover 90% of agricultural land in the EU. These standards apply to maintaining permanent grasslands at a set level, protection of peat lands and wetlands, ban on stubble burning, creation of buffer zone when fertilising fields near water bodies, ploughing management, maintaining protective cover on arable fields in winter, crop rotation systems, following fields, prohibition of the conversion or ploughing of permanent grasslands in areas designated as valuable ones in Natura 2000 areas (Najechalska, 2022).

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Research methods

The main goal of this study has been to measure and evaluate changes in values of indicators applied to the shaping of the environment in rural areas between the years 2010 and 2020. In order to achieve this aim, two working hypotheses were put forth:

- H1: sub-indicators representing individual categories assumed higher values in 2022 than in 2010.
- H2: The synthetic environmental management indicator achieves the highest values in provinces falling into the highest socio-economic development category.

The cognitive aim of the study was to determine values obtained by the sub-indicators and the synthetic indicator in the subsequent years covered by the study.

The study was carried out in three purposefully selected Polish provinces with different levels of socioeconomic development. The division into categories proposed by Witkowska-Dąbrowska (2022) supported the choice of the provinces. One province representing each of the categories was selected. Thus, the three provinces submitted to our analysis represented the following categories: pomorskie – first category, kujawsko-pomorskiego – second category, and warmińsko-mazurskiego – third category.

The first category was characterised by the highest level of socio-economic development indicators, while the third one scored the lowest. The chosen provinces are situated in the same region, namely the Northern Region, but they vary in development, as demonstrated by research results (Witkowską-Dąbrowska, 2022). They could, therefore, create a suitable database for comparison. Two strategic groups were distinguished in the provinces: rural municipalities and rural areas in urban-rural municipalities. The rural areas were understood as comprising villages according to the definition given in the Act (2003): 'a village – a settlement unit with dense or dispersed development and existing agricultural functions, or services and tourism related to them, which does not have municipal rights or the status of a city'. Despite the complexity of the problem of defining a rural area (Stanny, 2014), the above approach to the definition was dictated by the availability of statistical data grouped according to the administrative criterion (GUS, 2018; Krzysztofik, 2017). An advantage of this division is the comparability of our research results with other studies, while a disadvantage is that it does not enable us to take into account the different conditions present in rural areas around towns and especially big cities.

Thirty-nine variables were chosen to construct a synthetic indicator of shaping the environment. This number of variables resulted from the criterion adopted in the study, which narrowed down the data to such variables from which it was possible to extract results for rural areas and, at the same time, the ones the values of which depended on decisions made at the local government level.

The selected variables were grouped into six categories: the size and consumption of natural capital; the environmental quality of life of rural dwellers; emissions of pollutants to the environment; supply of environmental protection infrastructure; expenditure on environmental protection from municipal budgets; and impact of agriculture on the environment.

The assumption underlying the development of a synthetic indicator to be applied to evaluate environmental management was to keep its structure as simple as possible while making it express through its single numerical value all significant spheres of the observed field (Śleszyński, 2017). However, assuming that rural areas at the level of a municipality are the ones with the highest possible degree of comparability, a decision was made to narrow down the number of variables that were to serve for the ultimate construction of the indicator. The choice necessitated several compromises, and the proper selection of variables is mostly limited by the insufficient availability of data (Tuziak, 2010). Thus, it was decided that every category would be represented by 1 sub-indicator.

During the verification of statistical significance of correlation coefficients, the variables for which the correlation coefficient was not significant were eliminated. As a result, six variables were selected, one for each of the categories:

- size and consumption of natural capital – Wkś1 – number of planted trees and shrubs per 1,000 ha,
- environmental quality of life of residents – Wkś2 – share of the residents with access to a gas pipeline,
- emissions of pollutants to the environment – Wkś3 – share of biologically and chemically treated wastewater with elevated removal of biogenic substances in wastewater needing treatment,

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- supply of environmental protection infrastructure – Wkś4 – length of the sewage system per 100 km^2,
- expenditure on environmental protection from municipal budgets – Wkś5 – expenses on air and climate protection per 1 citizen (in PLN),
- impact of agriculture on the environment – Wkś6 – share of agricultural land kept under good agricultural practice in total agricultural land (%).

All sub-indicators illustrated stimulating factors. The synthetic indicator was calculated for the three chosen provinces, including the division into two strategic groups, that is rural municipalities and rural areas in urban-rural municipalities. Its value was approximating 1 in the two years, 2010 and 2022.

The time interval chosen for the study followed the new financial situation in environmental protection in the 2014-2022 financing perspective. The year 2010 served as the base year for comparison.

In the final stage of constructing the synthetic indicator, the Perkal method was employed (1953). A higher value of the Perkal indicator means higher evaluation (the higher, the better as all sub-indicators are stimulants) (1):

$$P_i = \frac{1}{m}\sum_{j=1}^{m} z_{ij}, \quad (1)$$

where:
P_i – Perkal indicator for i-th area,
m – number of sub-indicators composing the synthetic indicator,
z_{ij} – value of standardised feature j for i unit,
j – number of the indicator.

Because all sub-indicators were stimulants, normalisation was performed according to the formula (2):

$$z_{ij} = \frac{x_{ij} - min_{x_{ij}}}{max_{x_{ij}} - min_{x_{ij}}}, \quad (2)$$

Normalisation was carried out so that the many variables measured on different scales would appear in the same range. The normalised set of data comprised values from 0 to 1.

The Pearson linear correlation coefficient was applied in the study (Dziechciarz, 2003).

Results of the research and discussion

The first step in our evaluation of environmental management consisted of the presentation of values of the sub-indicators in the two years submitted to analysis, 2010 and 2022.

The indicator representing the category size and consumption of natural capital is the number of planted trees and shrubs per 1,000 ha (Figure 1).

Planting trees and shrubs is a measure that supports the greening of the environment, showing our care for nature and ecosystems in economy and social life. The research results proved that the number of new plants varied highly between the individual plants within the two strategic groups and between the two years. However, it was evident that more trees and shrubs were planted in rural areas of urban-rural municipalities than in rural municipalities. Moreover, there were more new plantings in rural municipalities in 2010 than in 2022, whereas the number of new trees and shrubs in rural areas of urban-rural municipalities was similar in both years. The plantings done in the warmińsko-mazurskie province particularly deserve criticism. Per 1,000 ha, the number of planted trees and shrubs was considerably lower than in the other two provinces. Kiryluk and Kostecka (2022), referring to the Ministerstwo Rolnictwa i Rozwoju Wsi (2019), point to the importance of tree planting in rural areas, especially on agricultural land, stating that 'the measurable importance of tree stands is: the protection of fields against the harmful effects of winds, maintaining air humidity in the ground layer, limiting wind and water erosion on light soils, and increasing water retention in soil.

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They are also a habitat for many fauna species that help fight diseases and pests of crops. Row, strip, or clump plantings should be introduced in a landscape with insufficient or improperly distributed woody vegetation'.

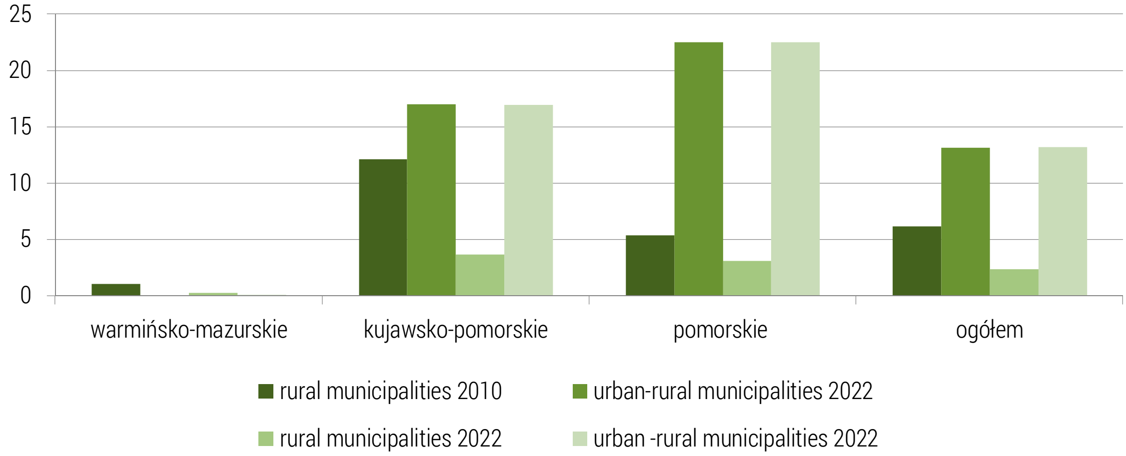

Figure 1. Number of planted trees and shrubs per 1,000 ha

The indicator chosen to represent the environmental quality of life is the share of residents connected to a gas pipeline (Figure 2). The results of this study show that in 2010, the share of the population with access to gas pipelines in the kujawsko-pomorskie and pomorskie provinces was higher in rural areas of urban-rural municipalities than in rural municipalities. In 2022, the higher share of residents able to use piped gas became notably higher in rural municipalities in total.

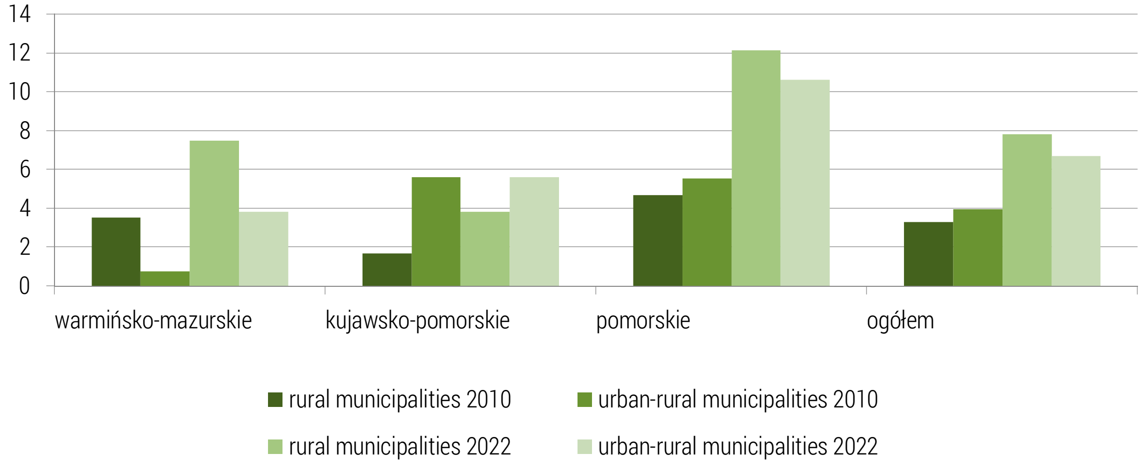

Figure 2. Share of the population connected to a gas network [%]

Energy security and sustainable development are undisputably the biggest challenges in the combat against climate change. While the call for an immediate shift to completely green and renewable energy seems unrealistic due to the immense financial issues and an inadequate structure of energy grids, an alternative to fossil fuels needs to be created. Natural gas, a naturally occurring fossil gas, is a clean source of energy compared to other fossil fuels, like coal, bitumen, and diesel oil. Natural gas is best suited for the sustainable transformation of renewable energy in every country around the world as it is more competitive than other fossil fuels and can support the integration of renewable energy sources. Moreover, gas can be produced using different technologies such as RES. The elasticity of energy systems using natural gas enables the integration of intermittent renewable energy sources, such as solar and wind power. CO_2 emissions caused by energy generation from natural gas can be lowered owing to advanced natural gas conversion technologies, integration with renewable energy sources and CCS technologies (Mohammad et al., 2021).

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The category pertaining to emissions of pollutants to the environment was represented by the indicator of the share of biologically and chemically treated wastewater with elevated removal of biogenic substances in wastewater needing treatment (Figure 3).

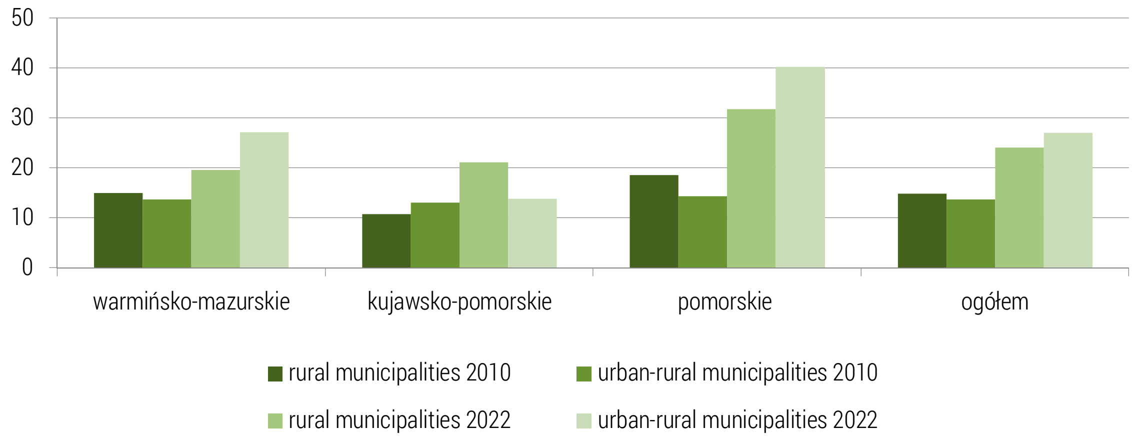

Figure 3. Share of biologically and chemically treated wastewater with elevated removal of biogenic substances in wastewater needing treatment [%]

The results of this research show that this indicator scored higher in all three provinces. This increase was particularly high in the pomorskie province, which is the province with the highest socio-economic development level. There can be a few solutions suitable for rural areas, and there are a number of factors to consider when choosing the right system. Decentralised wastewater treatment can be used to treat and dispose of relatively small quantities of wastewater and sewage from single households or groups of houses situated in relatively close proximity from one another (typically a few hundred metres) which are not connected to a central sewer system (Boguniewicz-Zabłocka & Capodaglio, 2017). In denselybuilt-up areas situated close to a town, linear sewers delivering wastewater and sewage to a large wastewater treatment plant can prove more useful. Regardless of which system is chosen, the share of treated wastewater in wastewater requiring treatment and the quality of treated wastewater are significant factors. Nitrogen and phosphorus compounds are basic biogenic substances in wastewater. While excess quantities of these biogenic substances discharged to soil and water can be harmful, there are studies indicating that phosphorus from wastewater can be extracted for commercial purposes. Phosphorus resources are non-renewable and irreplaceable but can be exhausted in the future (Garduño-Pineda et al., 2023; Li et al., 2016). Recovering phosphorus from wastewater can compensate for the shortage of phosphate rocks and promote global sustainable development (Mayer et al., 2016).

The above indicator is related to another one, such as the length of a sewage system per 100 km^2 (Figure 4), which in our study represented the supply of environmental protection infrastructure. There was a distinct increase in the value of this indicator between 2010 and 2022. However, as observed by Piasecki (2019), only 42% of the rural population in Poland was connected to a collective sewage system in 2019. Twice as many had access to water supply networks (85%). The cited author draws attention to the high ecological threat posed by the use of septic tanks in a closed system. On the other hand, the highest increase in environmental protection infrastructure was achieved by linear sewage systems (Piasecki et al., 2016).

The highest value of this indicator was determined in the pomorskie province, and the lowest one – in the warmińsko-mazurskie province, which again implicates some connection with the socio-economic development. In all the three provinces included in the study and in both years analysed, the indicator scored higher in rural municipalities and in rural areas of urban-rural provinces. There was also an evident increase in the value of this indicator in both rural areas of urban-rural municipalities and in rural municipalities over the years. This tendency is confirmed by results provided elsewhere (Surówka et al., 2021).

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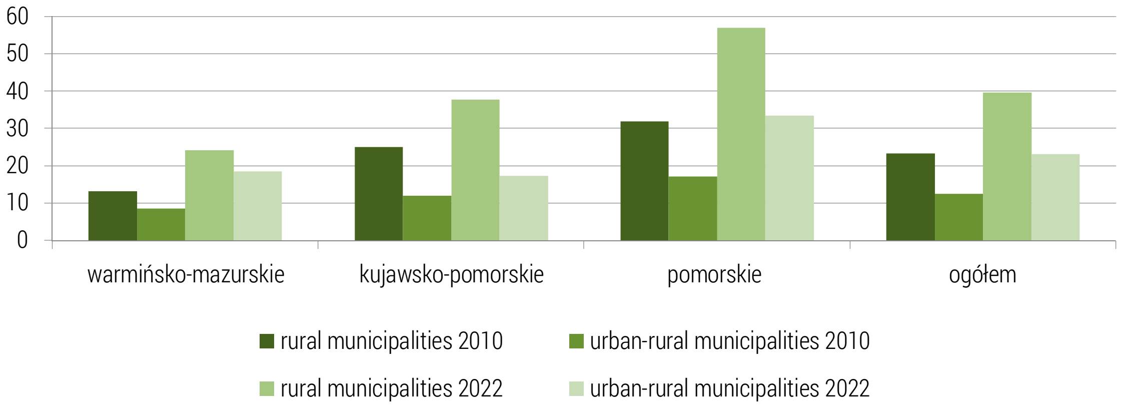

Figure 4. Length of sewage systems per 100 km^2

Investments in infrastructure take a long time to complete and are technically indivisible. The basic economic features of infrastructural developments are high capital intensity and long payback period. The former is due to the high investment expenditures necessary to achieve the intended outcome. The payback period consists of the long time needed to construct a given infrastructural facility and its technical indivisibility (Surówka et al., 2021; Choguill, 1996). Most infrastructural developments are co-funded by the European Union, yet the municipalities involved must allocate some funds from their budgets. The subsequent indicator was analysed in order to assess municipal expenditures dedicated to the protection of the environment (Fig. 5).

The indicator chosen to represent expenditures on environmental protection shows the expenditures on air and climate protection per 1 inhabitant of a municipality (in PLN).

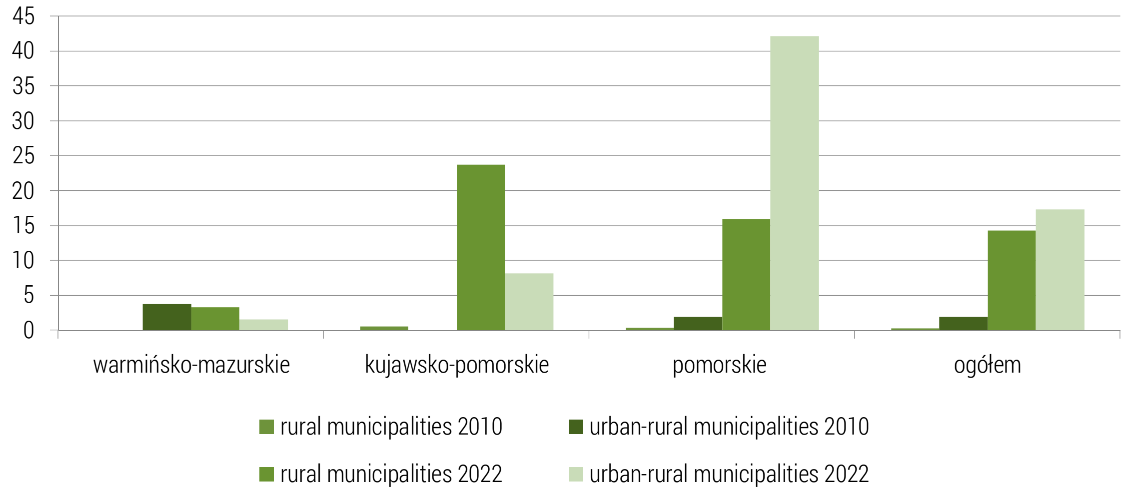

Figure 5. Expenditures on air and climate protection per 1 inhabitant of a municipality [in PLN]

The research results show how much the expenditures on air and climate protection rose during the analysed period. This is particularly evident in rural areas of urban-rural municipalities in the pomorskie province and in rural municipalities in the kujawsko-pomorskie province. Results of other studies (Pařila et al., 2022) reveal differences in the financing of particular areas of environmental protection in municipalities depending on the degree of dispersion of buildings, the density of the population, and the needs arising from these factors. It is emphasised that the cost of water protection measures is higher in areas less densely populated because houses are more scattered there; on the other hand, maintenance of green areas in housing estates is more expensive in localities closer to cities.

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The category related to the impact of agriculture on the environment (Figure 6) was represented by the indicator of the share of agricultural land maintained in good agricultural practice in total agricultural land (%). Under the Single Payment Scheme System (SPS), farmers in the EU are obligated to maintain the agricultural land for which they claim payments in good agricultural and ecological condition (Czyżewski & Trojanek, 2016; Falconer & Ward, 2000; Swanbank & Daugbjerg, 2006).

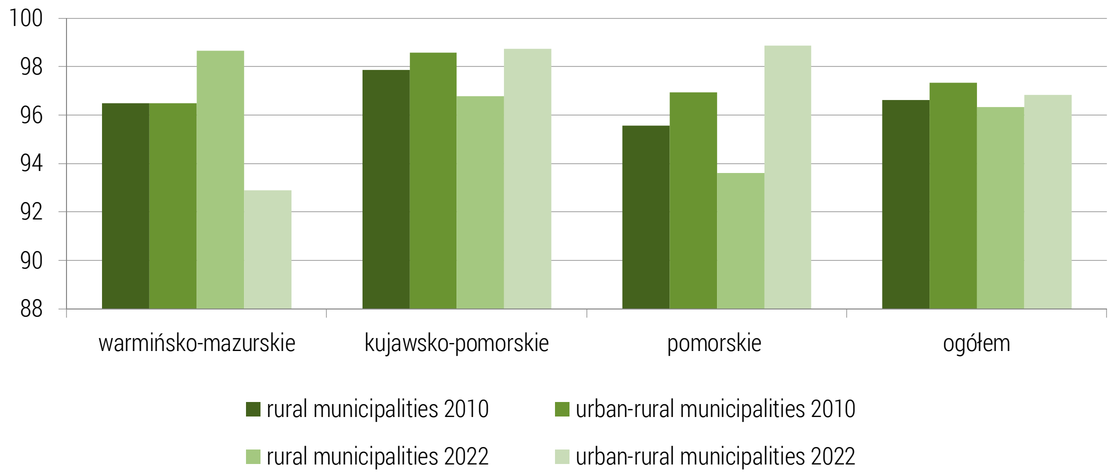

Figure 6. Share of agricultural land in good agricultural practice in total agricultural land [%]

The CAP Strategic Plan for 2023-2027 introduces changes with respect to good agricultural culture standards, which are already followed in Poland. In addition to the requirement to diversify crops, other obligations have been enforced, such as mandatory rotation of crops on 40% of arable land and the prohibition of growing the same crop for longer than 3 years as a main crop on all arable land in a farm. The definition of a crop' was modified, where by the division into spring and winter crops was abandoned for the purpose of rotation and diversification. The obligation to maintain soil under a protective cover in the autumn and winter will not apply to 80% of a farm's arable land. Soil cover has also become obligatory for permanent crops (fruit orchards). Ploughing management is expected to contribute to a decrease in the risk of soil degradation and erosion, including the aspect of land slope. The standard applies to arable land and permanent crops (that is orchards – fruit trees) on slopes of ≥ 14% (Ministerstwo Rolnictwa i Rozwoju Wsi, 2023).

It was not encouraging to note that prior to the entry into force of the stricter regulations mentioned above, the share of all farmland maintained in good farming culture was lower in 2022 than in 2010 in all three provinces studied. Although values of this indicator varied in the three provinces and the two strategic groups analysed, they indicated that the overall situation was deteriorating. In the warmińsko-mazurskie province, this indicator achieved the highest values in rural municipalities in the year 2022; in the other provinces, it also reached the highest level in 2022, but this happened in rural areas of urban-rural municipalities. An evident increase in values of this indicator was only observed in rural municipalities of the warmińsko-mazurskie province.

Values of the synthetic indicator of the shaping of the environment in rural areas of Polish provinces representing different socio-economic development categories, expressed in the form of the Perkal index, are comprised in Table 1. It is worth recalling that Category 1 stands for the poorest, while Category 3 denotes the best socio-economic development. Irrespective of the province in which they were situated, rural municipalities throughout the whole time period analysed were characterised by the higher value of the synthetic indicator than rural areas in urban-municipal muncipalities. The highest values of this indicator, both in 2010 and 2022, were achieved by rural municipalities in the pomorskie province. In 2010, the worst indicator values were determined for rural areas in urban-rural areas of the warmińsko-mazurskie province, while in 2022, the lowest-scoring were such areas in the kujawsko-pomorskie province. In that province, there was a decrease in 2022 compared to 2010. Thus, hypothesis I, suggesting that sub-indicators representing the analysed categories of environment shaping scored higher in 2022 than in 2010, had to be refuted.

Table 1. Values of the Perkal index for the analysed areas

Categories	Province	Rural municipalities		Areas in urban-municipal muncipalities	
		2010	2022	2010	2022
1	Warmińsko-mazurskie	0.223	0.257	0.213	0.258
2	Kujawsko-pomorskie	0.248	0.298	0.244	0.223
3	Pomorskie	0.270	0.359	0.257	0.348

The synthetic environmental management indicator calculated for rural municipalities and rural areas of urban-rural municipalities in the kujawsko-pomorskie, pomorskie and warmińsko-mazurskie provinces were submitted to verification by calculating the Pearson coefficient of the linear correlation between the environmental management indicator calculated for the municipalities and the synthetic socio-economic development of the municipalities computed and presented by Witkowska-Dąbrowska (2022). It was presumed that the environmental management indicator would faithfully reflect the analysed phenomenon if the value of the Pearson coefficient exceeded 0.7. This condition was fulfilled for both the overall value of the environmental management indicator and its scores for the distinguished types of municipalities. As regards the comparison of the environmental management indicator values versus the synthetic indicator of the socio-economic development of the analysed areas, the Pearson correlation coefficient exceeding 0.7 was met in all three provinces.

No statistically significant difference was observed between the average level of the environmental management indicator in rural municipalities and in rural areas in urban-rural municipalities in the kujawsko-pomorskie and warmińsko-mazurskie provinces. However, in the pomorskie province, the above difference was statistically significant. A comparison of the values of the synthetic indicator in the three analysed provinces demonstrated that the highest improvement between the two studied years took place in the province with the highest socio-economic development level (pomorskie), both in its rural municipalities and in rural areas of urban-rural municipalities. This confirms the second research hypothesis (H2), proposing that the synthetic environmental management indicator achieves higher values in provinces classified into the best socio-economic development category. Similar research results have been reported by Witkowska-Dąbrowska (2022).

Conclusions

The pomorskie province proved to be the undisputed leader among rural areas of urban-rural municipalities, where the average number of planted trees and shrubs per 1,000 ha (Wkś1), share of the population connected to gas grids (Wkś2), share of biologically and chemically treated wastewater with elevated removal of biogenic substances in wastewater requiring treatment (Wkś3), length of the sewage network per 100 km^2 (Wkś4) scored the highest. Also, with respect to the average spending on air and climate protection per 1 resident (in PLN) (Wkś5) and average share of agricultural land in good agricultural condition in total agricultural land (%) (Wkś6) obtained the highest scores in the mentioned areas in 2022. In 2010, the warmińsko-mazurskie province scored the best as regards the average expenses on air and climate protection per capita (in PLN) (Wkś5) while the kujawsko-pomorskie province achieved the highest score for the share of agricultural land in good agricultural condition in total agricultural land (%) (Wkś6).

The comparison of years 2010 and 2022 showed that the rural municipalities in the warmińsko-mazurskie province improved their position in 5 of the six analysed indicators, that is, all indicators except the number of planted trees and shrubs per 1,000 ha. The greatest improvement was noted in the share of the population using piped gas and in the length of sewage networks per 100 km^2. There was no decrease in the expenses on air and climate protection per capita in any of the rural municipalities, although in 1/3 of these units, such expenses remained to equal PLN 0. As for rural areas in urban-rural municipalities, improvement occurred in 4 indicators, with the highest rise recorded for the share of biologically and chemically treated wastewater with elevated removal of biogenic substances in wastewater requiring treatment. In contrast, there was a decrease in the

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values of two indicators: expenses on air and climate protection per capita and share of agricultural land in good agricultural condition in total agricultural land. None of the analysed areas scored worse in the share of the population with access to gas pipelines and the length of sewerage networks per 100 km^2.

Both rural municipalities and rural areas of urban-rural municipalities in the pomorskie province should be considered as the most developed ones, while rural municipalities and rural areas in urban-rural municipalities in the warmińsko-mazurskie province appear the least developed. The values of the synthetic environmental management indicator followed the same pattern. Assuming that the higher its value, the better, it should also be assumed that the value of the environmental management indicator would be the lowest in the province with the lowest socio-economic development. On the other hand, the province with the highest socio-economic development scored the highest in terms of the environmental management indicator.

Koreleski (2009) maintains that environmental management is largely the responsibility of local governments, resulting from the principle of subsidiarity and the laws obligating each municipality to provide their residents with a decent quality of life.

The contribution of the authors

Conceptualization, M. W.-D.; literature review, M. W.-D. and N.Ś.; methodology, M. W.-D. and N.Ś.; formal analysis, M. W.-D. and N.Ś.; writing, M. W.-D. and N.Ś.; conclusions and discussion, M. W.-D. and N.Ś.

The authors have read and agreed to the published version of the manuscript.

References

Act from 29 August 2003. Act on official names of localities and physiographic objects. Journal of Laws No. 166, item 1612. https://isap.sejm.gov.pl/isap.nsf/DocDetails.xsp?id=WDU20031661612 (in Polish).

Ahmed, M. F., & Rahman, M. M. (2000). Water Supply and Sanitation. Rural and Low Income Urban Communities, ITN-Bangladesh. https://scholar.google.com/citations?view_op=view_citation&hl=pl&user=SokkPQ4AAAAJ&citation_for_view=SokkPQ4AAAAJ:D90uR9ClOh8C

Bednarek, A., Klepacka, A., & Siudek, A. (2023). Development barriers of agricultural biogas plants in Poland. Economics and Environment, 84(1), 229-258. https://doi.org/10.34659/eis.2023.84.1.528

Biernacka, E. (2009). Quo vadis dyscyplino „Kształtowanie środowiska"? Zeszyty Problemowe Postępów Nauk Rolniczych, 540, 15-23. https://www.infona.pl/resource/bwmeta1.element.dl-catalog-d010e256-145d-47cf-b18f-25e6b69e3a17 (in Polish).

Boguniewicz-Zabłocka, J., & Capodaglio, A. G. (2017). Sustainable Wastewater Treatment Solutions for Rural Communities: Public (Centralized) or Individual (On-Site) – Case Study. Economic and Environmental Studies, 4(44), 1103-1119. https://www.ceeol.com/search/article-detail?id=608286

Brandyk, T. (2001). Kształtowanie środowiska jako dyscyplina naukowa. Zeszyty Problemowe Postępów Rolniczych, 476, 15-29. https://bibliotekanauki.pl/articles/804193.pdf (in Polish).

Chen, Y., Huang, R., Guan, Y., Zhuang, T., Wang, Y., Tan, R., Wang, J., Zhou, R., Wang, B., Xu, J., Zhang, X., Zhou, K., Sun, R., & Chen, M. (2021). The profiling of elements and pesticides in surface water in Nanjing, China with global comparisons. Science of The Total Environment, 774, 145749. https://doi.org/10.1016/j.scitotenv.2021.145749

Chilczuk, M. (1973). *Ochrona i kształtowanie współczesnego środowiska wiejskiego. Kształtowanie i ochrona środowiska w systemach hydrograficznych.* Warszawa: Stowarzyszenie Inżynierówi Techników Wodnych i Melioracyjnych. (in Polish).

Choguill, C. L. (1996). Ten steps to sustainable infrastructure. Habitat International, 20(3), 389-404. https://doi.org/10.1016/0197-3975(96)00013-6

Czudec, A., Miś, T., & Zając, D. (2018). *Zrównoważony rozwój obszarów wiejskich w wymiarze regionalnym*. Poznań: Wydawnictwo Bogucki Wydawnictwo Naukowe. (in Polish).

Czyżewski, B., & Trojanek, R. (2016). Czynniki wartości ziemi rolnej w kontekście zróżnicowanych funkcji obszarów wiejskich w Polsce. Zagadnienia Ekonomiki Rolnej, 2(347), 3-25. http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.desklight-8784f19c-b67a-41af-9f03-6d5dbd146e74 (in Polish).

Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment, Pub. L. No. 31991L0271, 135 OJ L (1991). https://eur-lex.europa.eu/eli/dir/1991/271/oj

Dziechciarz, J. (Ed.). (2003). *Ekonometria. Metody, przykłady zadania.* Wrocław: Wydawnictwo Akademii Ekonomicznej we Wrocławiu. (in Polish).

Dzirba, D. (2012). Gazowe sieci inteligentne – opcja dla energetyki? Nafta-Gaz, 68(3), 184-191. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-article-BGPK-3544-3378 (in Polish).

EEA. (2014). *Jakość naszego życia a środowisko. Budowanie zasobooszczędnej i zrównoważonej gospodarki w Europie.* https://www.eea.europa.eu/pl/publications/sygnaly-eea-2014-jakosc-naszego (in Polish).

Falconer, K., & Ward, N. (2000). Using modulation to green the CAP: the UK case. Land Use Policy, 17(4), 269-277. https://doi.org/10.1016/S0264-8377(00)00036-3

Garduño-Pineda, L., Linares-Hernández, I., Martínez-Miranda, V., Teutli-Sequeira, E. A., Martínez, J., Cruz, S., & García-Sánchez, J. J. (2023). Sustainable removal of nutrients (n and p) in a wastewater treatment plant, with eggshell (biocalcium). Heliyon, 9(11), e21581. https://doi.org/10.1016/j.heliyon.2023.e21581

Górnicki K. (2012*). Kapitał naturalny jako kategoria socjologiczna*. Pogranicze. Studia Społeczne, XX, 271–296. https://doi.org/10.15290/pss.2012.20.15

GUS. (2018). *Obszary wiejskie w Polsce w 2016 roku.* https://stat.gov.pl/obszary-tematyczne/rolnictwo-lesnictwo/rolnictwo/obszary-wiejskie-w-polsce-w-2016-roku,2,3.html (in Polish).

GUS. (2021). *Powszechny Spis rolny 2020. Raport z wyników.* https://stat.gov.pl/obszary-tematyczne/rolnictwo-lesnictwo/psr-2020/powszechny-spis-rolny-2020-raport-z-wynikow,4,1.html (in Polish).

Halamska, M. (2017). Przestrzenne zróżnicowanie struktury społecznej wsi. Acta Universitatis Lodziensis Folia Sociologica, 63, 7-28. https://doi.org/10.18778/0208-600X.63.02 (in Polish).

Hellwig, Z. (1968). Zastosowanie metody taksonomicznej do typologicznego podziału krajów ze względu na poziom ich rozwoju oraz zasoby i strukturę wykwalifikowanych kadr. Przegląd Statystyczny, 15(4), 307-326. (in Polish).

Hollas, C. E., Bolsan, A. C., Venturin, B., Bonassa, G., Tápparo, D. C., Cândido, D., Antes, F. G., Vanotti, M. B., Szögi, A. A., & Kunz, A. (2021). Second-Generation Phosphorus: Recovery from Wastes towards the Sustainability of Production Chains. Sustainability, 13, 5919. https://doi.org/10.3390/su13115919

Huseynov, E. (2011). Planning of sustainable cities in view of green architecture. Procedia Engineering, 21, 534-542. https://doi.org/10.1016/j.proeng.2011.11.2048

Jaworska, A. P. (2016). *Porównanie perspektyw finansowych 2007-2013 i 2014-2020 w Unii Europejskiej na przykładzie Polski*. Projekt realizowany z Narodowym Bankiem Polskim w ramach programu edukacji ekonomicznej. VII Edycja 2015/2016. UWM w Olsztynie. https://uwm.edu.pl/wne/katedry/kmakro/files/e7_p19.pdf (in Polish).

Kiryluk, A., & Kostecka, J. (2022). Sustainable development in rural areas in the perspective of a decade of ecosystem restoration. Economics and Environment, 4(83), 117-149. https://doi.org/10.34659/eis.2022.83.4.535

Kłos, L. (2013). Zagrożenia wynikające ze stanu gospodarki wodno-kanalizacyjnej na obszarach wiejskich. Folia Pomeranae Universitatis Technologiae. Oeconomica, 299(70), 111-118. https://bibliotekanauki.pl/articles/78983.pdf (in Polish).

Koreleski, K. (2009). Problematyka ochrony i kształtowania środowiska w dokumentach służących realizacji zrównoważonego rozwoju gmin. Infrastruktura i Ekologia Terenów Wiejskich, 4, 31-42. https://bibliotekanauki.pl/articles/59581 (in Polish).

Kryk, B. (2015). Środowiskowe uwarunkowania jakości życia w województwie zachodniopomorskim na tle Polski. Economics and Environment, 54(3), 170-182. https://bazekon.uek.krakow.pl/en/rekord/171392811 (in Polish).

Krzysztofik, M. (2017). Problematyka prawna pojęcia obszaru wiejskiego. Studia Iuridica Lublinensia, 26(1), 299-314. https://doi.org/10.17951/sil.2017.26.1.299 (in Polish).

Li, B. Qiu, Y., Zhang, Ch., Chen L., Shi, H. (2016). *Understanding biofilm diffusion profiles and microbial activities to optimize integrated fixed-film activated sludge process*. https://doi.org/10.1016/j.cej.2016.05.048

Lin, Z., He, L., Zhou, J., Shi, S., He, X., Fan, X., Wang, Y., & He, Q. (2022). Biologically induced phosphate precipitation in heterotrophic nitrification processes of different microbial aggregates: Influences of nitrogen removal metabolisms and extracellular polymeric substances. Bioresource Technology, 356, 127319. https://doi.org/10.1016/j.biortech.2022.127319

Małuszyńska, I., Blicharska, M. W., Białczak, E. M., & Małuszyński, M. J. (2018). Znaczenie terenów zieleni miejskiej w kreowaniu polityki przestrzennej miast na przykładzie Pruszkowa. Spae-Society-Ekonomy, 23, 41-54. https://doi.org/10.18778/1733-3180.23.03 (in Polish).

Ministerstwo Infrastruktury. (2017). *Aktualizacja Krajowego Programu Oczyszczania Ścieków Komunalnych.* https://www.gov.pl/web/infrastruktura/vi-aktualizacja-krajowego-programu-oczyszczania-sciekow-komunalnych (in Polish).

Ministerstwo Rolnictwa i Rozwoju Wsi. (2019). *Kodeks dobrej praktyki rolniczej w zakresie ograniczania emisji amoniaku.* https://www.gov.pl/web/rolnictwo/kodeks-dobrej-praktyki-rolniczej-w-zakresie-ograniczania-emisji-amoniaku (in Polish).

Ministerstwo Rolnictwa i Rozwoju Wsi. (2022). *Najistotniejsze modyfikacje Planu Strategicznego WPR na lata 2023-2027.* https://www.gov.pl/web/rolnictwo/najistotniejsze-modyfikacje-planu-strategicznego-wpr-na-lata-2023-2027 (in Polish).

Ministerstwo Rolnictwa i Rozwoju Wsi. (2023). *Plan Strategiczny dla Wspólnej Polityki Rolnej na lata 2023-2027*. https://www.gov.pl/web/rolnictwo/plan-strategiczny-dla-wspolnej-polityki-rolnej-na-lata-2023-27 (in Polish).

Mayer, B. K., Baker, L.A., Boyer, T.H., Drechsel, P., Gifford, M., Hanjra M.A., Parameswaran, P., Stoltzfus, J., Westerhoff, P., Rittmann, B. E. (2016). *Total Value of Phosphorus Recovery*. Environmental Science & Technology 2016 50 (13), 6606-6620. https://doi.org/10.1021/acs.est.6b01239

Mohammad, N., Ishak, W., Mustapa, S., & Ayodele, B. (2021). Natural Gas as a Key Alternative Energy Source in Sustainable Renewable Energy Transition. Frontiers in Energy Research, 9, 625023. https://doi.org/10.3389/fenrg.2021.62502

Mukherjee, C., Denney, J., Mbonimpa, E. G., Slagley, J., & Bhowmik, R. (2020). A review on municipal solid waste-to-energy trends in the USA. Renewable and Sustainable Energy Reviews, 119, 109512. https://doi.org/10.1016/j.rser.2019.109512

Najechalska, M. (2022). *Normy Dobrej Kultury Rolnej od 2023 roku.* https://www.scribd.com/document/648445678/Normy-Dobrej-Kultury-Rolnej-2023-Mazowiecki-ODR (in Polish).

Osiniak, T., Poskrobko, B., & Sadowski, A. (1993). *Wigierski Park Narodowy a jego mieszkańcy*. Białystok-Kraków: Wydawnictwo Ekonomia Środowisko. (in Polish).

Ostachowski, P. (2021). Ochrona powietrza i klimatu jako przedmiot wydatków inwestycyjnych gmin powiatu pińczowskiego. Rocznik Administracji Publicznej, (7), 73-90. https://doi.org/10.4467/24497800RAP.21.004.14820 (in Polish).

Pagnon, J., & Midler, E. (2022). *Environmental threats to rural areas*. https://ieep.eu/news/environmental-threats-to-rural-areas/

Pařil, V., Ondrůšková, B., Krajíčková, A., & Zelenáková, P. (2022). The cost of suburbanization: spending on environmental protection. European Planning Studies, 30(10), 2002-2021. https://doi.org/10.1080/09654313.2021.2002270

Perkal, J. (1953). O wskaźnikach antropologicznych. Przegląd Antropologiczny, 19, 210-221. https://www.academia.edu/45647111/Perkal_J_O_wska%C5%BAnikach_antropologicznych (in Polish).

Petelewicz, M. (2016). Jakość życia – wprowadzenie. In M. Petelewicz & T. Drabowicz (Eds.), *Jakość życia – Globalnie i lokalnie. Pomiar i wizualizacja* (pp. 7-32). Łódź: Wyd. Katedra Socjologii Ogólnej, Wydział Ekonomiczno-Socjologiczny, Uniwersytet Łódzki. https://core.ac.uk/download/pdf/80534786.pdf (in Polish).

Piasecki, A. (2019). Water and Sewage Management Issues in Rural Poland. Water, 11(3), 625. https://doi.org/10.3390/w11030625

Piasecki, A., Jurasz, J., & Miesikowski, M. (2016). Development of Water and Wastewater Management in the Eastern Provinces of Poland. Economics and Environment, 57(2), 69-82. https://www.ekonomiaisrodowisko.pl/index.php/journal/article/view/283/274

Pilarska, A. (2014). Dostęp do sieci gazowej i jej stan w gminach miejsko-wiejskich południowej części województwa kujawsko-pomorskiego. Acta Scientiarum Polonorum. Administratio Locorum, 13(4), 37-46. https://www.ceeol.com/search/article-detail?id=817229 (in Polish).

Piskowska-Wasiak, J. (2018). Możliwości komplementarnego wykorzystania gazu ziemnego i odnawialnych źródeł energii. Nafta-Gaz, 4, 290-298. https://bibliotekanauki.pl/articles/1835203.pdf (in Polish).

Ribeiro, A. P., & Rode, M. (2019). Residual biomass energy potential: perspectives in a peripheral region in Brazil. Clean Technologies and Environmental Policy, 21(4), 733-744. https://doi.org/10.1007/s10098-019-01675-3

Rokicka, E. (1998). Jakość życia społecznego a środowisko w ujęciu globalnym i lokalnym. In K. Kazimierska (Ed.), *Socjologia i społeczeństwo polskie* (p. 134). Łódź: Omega-Praksis. (in Polish).

Śleszyński, J. (2017). Wskaźniki trwałego rozwoju na poziomie lokalnym. Optimum. Studia Ekonomiczne, 88(4), 39-52. https://doi.org/10.15290/ose.2017.04.88.04 (in Polish).

Stanny, M. (2014). Wieś, obszar wiejski, ludność wiejska – o problemach z ich definiowaniem. Wielowymiarowe spojrzenie. Wieś i Rolnictwo, 1(162), 1-16. https://kwartalnik.irwirpan.waw.pl/wir/article/view/488 (in Polish).

Surówka, M., Popławski, Ł., & Fidlerová, H. (2021). Technical Infrastructure as an Element of Sustainable Development of Rural Regions in Małopolskie Voivodeship in Poland and Trnava Region in Slovakia. Agriculture, 11(2), 141. https://doi.org/10.3390/agriculture11020141

Sutkowska, E. (2006). Współczesny kształt i znaczenie zieleni miejskiej jako zielonej przestrzeni publicznej w strukturze miasta – przestrzeń dla kreacji. Teka Komisji Architektury, Urbanistyki i Studiów Krajobrazowych, 2, 184-192. http://yadda.icm.edu.pl/baztech/element/bwmeta1.element.baztech-e529a4e6-7b40-459d-9670-4a33505682ed (in Polish).

Swanbank, A., & Daugbjerg, C. (2006). The 2003 CAP reform: accommodating WTO pressures. Comparative European Politics, 4, 47-64. https://doi.org/10.1057/palgrave.cep.6110069

Tomczykowska, M., Drzewiecki, A., & Kulikowska, D. (2009). Intensyfikacja procesu denitryfikacji ścieków na przykładzie oczyszczalni w Tyrowie. Czasopismo Techniczne. Środowisko, 106(3Ś), 111-120. https://repozytorium.biblos.pk.edu.pl/resources/33600 (in Polish).

Tuziak, A. (2010). Społeczno-ekonomiczne aspekty zrównoważonego rozwoju w ujęciu globalnym i lokalnym. Problemy Ekorozwoju, 5(2), 39-49. https://ekorozwoj.pollub.pl/no10/d.pdf (in Polish).

Wałęga, A., Plesiński, K., Chmielowski, K., & Satora, S. (2010). Możliwości zwiększenia efektywności usuwania ze ścieków azotu i fosforu w oczyszczalni w Łopusznej. Infrastruktura i Ekologia Terenów Wiejskich, 1, 111-123.

https://yadda.icm.edu.pl/agro/element/bwmeta1.element.dl-catalog-f100a512-ae2b-4b39-9aad-a514d708bd78 (in Polish).

Wilkin, J. (2011). Wielofunkcyjność wsi i rolnictwa a rozwój zrównoważony. Wieś i Rolnictwo, 4 (153), 17-30. https://kwartalnik.irwirpan.waw.pl/wir/issue/view/22 (in Polish).

Witkowska-Dabrowska, M. (2022). *Kształtowanie środowiska na obszarach wiejskich – w stronę rozwoju trwałego i zrównoważonego*. Olsztyn: Wydawnictwo Uniwersytetu Warmińsko-Mazurskiego w Olsztynie. (in Polish).

Wolska, Z. (2010). Polityka Unii Europejskiej wobec zmian klimatycznych. Studia Europejskie / Centrum Europejskie Uniwersytetu Warszawskiego, 3, 60. https://journalse.com/pliki/pw/3-2010_wolska.pdf (in Polish).

Ziółkowski, M. (2015). Strategiczne zarządzanie rozwojem gminy. Ruch Prawniczy, Ekonomiczny i Socjologiczny, 77(1), 145-165. https://doi.org/10.14746/rpeis.2015.77.1.8 (in Polish).

Mirosława WITKOWSKA-DĄBROWSKA • Natalia ŚWIDYŃSKA

WYKORZYSTANIE WIELOWYMIAROWEJ ANALIZY PORÓWNAWCZEJ DO OCENY POZIOMU SYNTETYCZNEGO WSKAŹNIKA KSZTAŁTOWANIA ŚRODOWISKA NA OBSZARACH WIEJSKICH W POLSCE

STRESZCZENIE: Głównym celem badań był pomiar oraz ocena zmian w poziomie wskaźników kształtujących środowisko obszarów wiejskich w latach 2010 i 2022. Badaniami objęto trzy województwa reprezentujące odmienne klasy rozwoju społeczno-gospodarczego. W województwach wyróżniono dwie grupy strategiczne badań: gminy wiejskie i obszary wiejskie w gminach-miejsko-wiejskich. Z wykorzystaniem metody Perkala skonstruowano syntetyczny wskaźnik pomiaru kształtowania środowiska na obszarach wiejskich. Za pomocą współczynnika korelacji Pearsona udało się uzyskać wyniki pozwalające na stwierdzenie, że w najwyższym stopniu poprawa syntetycznego wskaźnika kształtowania środowiska nastąpiła w województwie o najwyższym poziomie rozwoju społeczno-gospodarczego, mimo, że wskaźniki cząstkowe nie we wszystkich badanych grupach uległy poprawie w okresie od 2010 do 2022 roku. Kształtowanie środowiska to w znacznej mierze zadanie samorządowe. Wskazanie metod monitorowania środowiska może być pomocne w podejmowaniu decyzji na poziomie samorządów co do kierunków kształtowania środowiska na danym obszarze, bowiem zaproponowany wskaźnik obejmuje tylko te elementy, na które mogą mieć wpływ działania podjęte przez samorządy.

SŁOWA KLUCZOWE: kształtowanie środowiska, obszary wiejskie, syntetyczny wskaźnik

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