



## Article

# The Use of Selected Landscape Metrics to Evaluate the Transformation of the Rural Landscape as a Result of the Development of the Mining Function—A Case Study of the Puchaczów Commune

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**Abstract:** Landscape metrics have been used for years in research on the evolution of landscapes. They are also important in the process of monitoring changes taking place in the functional and spatial structure of rural areas. The main aim of this article is to assess the transformation of the rural landscape of the Puchaczów commune, which is based on a comparative analysis of selected landscape metrics. In the Puchaczów commune, due to the availability of raw materials, a mining industry has developed, which has a decisive influence on the development of the region. The study included schemes of the commune's land cover from four periods: the pre-war period, the 1960s and the 1970s (i.e., shortly before the construction of the hard coal mine), 1990–2000, and 2020. Then, for the given time frames, with the help of the FRAGSTATS version 4.2 program, the following landscape indicators were calculated: the percentage of the landscape coverage by particular land cover units, the number of patches, the mean class area, the Shannon diversity index, and the Simpson diversity index. A comparative analysis of landscape metrics showed that the landscape of the Puchaczów commune was constantly transformed in the years 1937–2020. Despite the decrease in the area of agricultural land, agricultural production remains the dominant function of the commune. The percentage of industrial areas is the smallest, but the metric values do not reflect the enormous environmental impact of the mine. A broader description of the changes taking place in the landscape of the Puchaczów commune can therefore be obtained only by combining research with the use of landscape metrics and analyses of the impact of land cover units on the environment.

**Keywords:** rural areas; industrial areas; landscape metrics

## 1. Introduction

The development of rural areas has always been associated with natural conditions. In the past, the landscape predominantly determined the development of settlement and agricultural functions. Until the land reform in Poland in 1944, the shaping of the spatial structure of the village was strongly related to the existence of land estates, the center of which was a manor house with an associated farm. Political changes after 1944 have led to the current natural and cultural values not affecting the shaping of rural areas as much as before, but they are still important factors from the ecological, economic, and social point of view [1,2]. Due to the nature of the changes, two stages are noticeable in the history of the development of the Polish countryside: traditional and contemporary. Until the second half of the twentieth century, a traditional village functioned, mainly characterized by agricultural activity. Since the 1990s, i.e., after the systemic changes in Poland, a strong trend of promoting the multifunctional development of rural areas has been noticeable [3,4].

Multifunctional development of rural areas is a process that involves the activation of non-agricultural rural activities and the diversification of economic space. This development

can be considered both in the socio-economic and territorial spheres [5]. The socio-economic aspect concerns the rational use of production resources in rural areas. The territorial scope, on the other hand, is related to the spatial planning process and consists of locating society's activity within a specific economic field not directly related to agriculture [6]. Nowadays, the Polish countryside is subject to dynamic changes, and there is a transformation of the perception of its potential—from a space used primarily for the production of food to a place that creates new living conditions, offering environmental goods. Tourism, recreation, housing, and non-agricultural use of natural resources, such as the mining industry, are becoming increasingly important [7]. It should be noted that the resources of the natural environment and cultural heritage of rural areas are specific factors that may strengthen the process of multifunctional development [8–10]. They constitute the basis for local development [11] and create the competitive advantage of individual regions [12].

The emergence of new functions in rural areas causes structural and spatial transformations, which may be a planned process based on properly and comprehensively prepared planning documents, but also non-controlled and random when it occurs spontaneously, not covering the broad spectrum of problematic spatial changes. In the latter case, the natural and cultural values of the countryside may disappear, and the spatial order may be upset [10,13]. Changing land use not only affects the visual aspect of the landscape, but causes a number of changes to the environment. It is worth noting here that the issue of land use transformations and the resulting consequences is a multifaceted issue, concerning regions all over the world. It may be related to the expansion of agriculture [14] and progressive urbanization [15]. Therefore, given the process of enormous climate change, which is already a fact, uncontrolled transformation of the landscape is particularly dangerous. There is therefore a real need to continuously monitor and evaluate changes in land use. According to Solon [16], a coherent landscape monitoring system is one of the tasks linking the state administration (responsible for the formal aspect of the functioning and implementation of landscape monitoring) with scientists dealing with ecological and landscape research. Such a system cannot be based only on theoretical issues, but should be applied in practice, supporting spatial management and environmental protection. Therefore, landscape monitoring requires the development of a method that quantifies its condition. Such possibilities are ensured by the use of landscape metrics in research [17].

The main goal of this article is to assess the transformation of the rural landscape in which, apart from the traditional agricultural function, the mining industry has developed. The territorial scope of the research covered the Puchaczów commune, located in the Lubelskie Voivodeship. The substantive scope included a comparative analysis of land cover forms from four periods: pre-war, the 1960s and 1970s (i.e., the time shortly before the construction of the hard coal mine), 1990–2000, and 2020. In order to determine the scale and directions of changes that took place in the commune as a result of the mining industry, landscape metrics were used: percentage of commune coverage by a given unit, number of patches, average plot area, the Shannon diversity index and the Simpson diversity index. The comparison of the values of landscape metrics in the presented time frames made it possible to assess changes in land use and was helpful in determining the dynamics of this process.

Landscape metrics (landscape indicators) are defined as measurable biotic or abiotic features of the environment that enable the acquisition of quantitative data relating to ecological resources and the functioning of the landscape [18–21]. Due to the large number of landscape metrics, they use different methods of classification. One of them takes into account the described feature of the landscape and makes it possible to distinguish two groups of metrics: landscape composition indicators, which refer to the diversity and abundance of individual types of patches without taking into account their spatial distribution, and landscape configuration indicators that reflect the physical location of the patches in space [17,22,23]. It is also common to divide landscape metrics in terms of the element of the landscape structure, which is included in the method of calculating the indicator [15]. In this case, we can distinguish indicators of area and boundaries, shape, core surface, contrast, aggregation, and diversity [17,24].

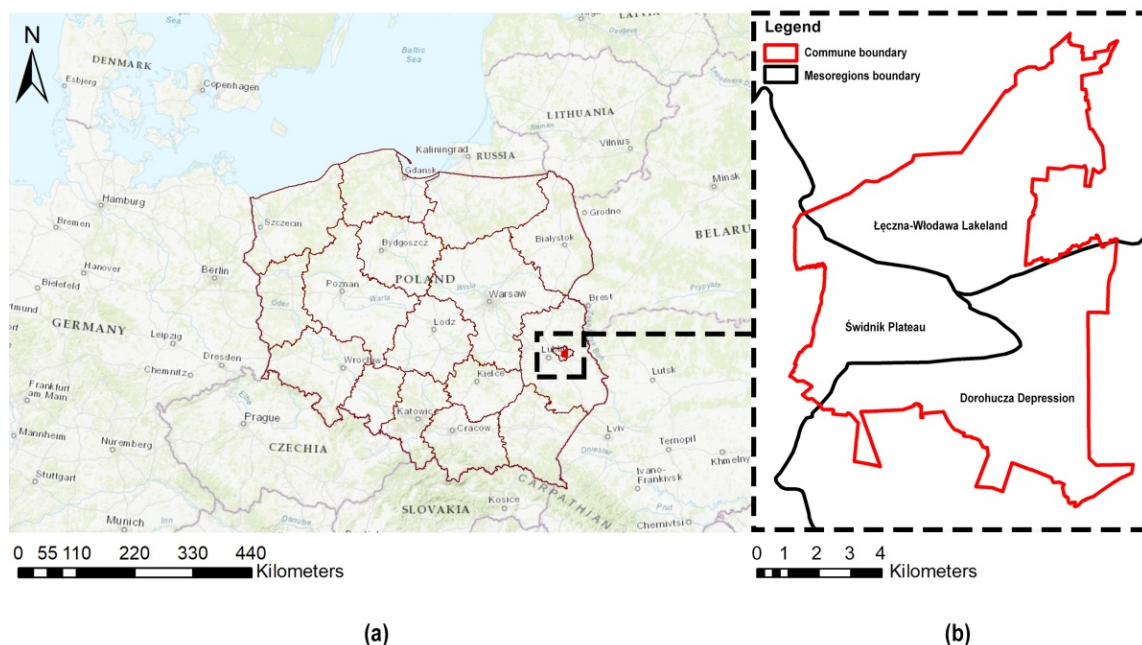
Landscape metrics are widely used in studies on landscape variability over the years [19,23,25–27], both in terms of ecological and visual values [28]. The metrics are used to analyze the state, the characteristics of the spatial structure, and the functioning of various types of landscapes, including urban [23,26,29], rural [30–32], forest [19], and degraded landscapes (e.g., by extractive industries and intensive agriculture [33]). As emphasized by Roo-Zielińska et al. [20], landscape metrics, apart from their use in indication, also have a wider meaning. It is possible to use the indicators to document the evolution of the landscape, search for relationships between the elements of the structure, the functioning, and the development of the landscape, and to test the hypotheses relating to the limit values [20]. After exceeding limit value, the type of the structure of the environment and the factors shaping the space change. The advantage of landscape indicators is that their values can be determined in relation to various spatial units: geographic, biogeographic, political and administrative, and geometric (contractual) [17]. Landscape metrics can also be based on single measurements or a combination of different measures [20,21]. There are currently several programs that allow the automatic computation of landscape metrics from maps of land cover forms [22,34].

The issues presented in this article are part of the research on the transformations of rural areas in Poland and are an example of the use of landscape metrics for the purposes of spatial planning at the local level in an agricultural landscape.

## 2. Materials and Methods

### 2.1. Study Area

The territorial scope of the study included the Puchaczów commune within its current administrative borders. The commune is located in the Łęczna powiat, in the Lublin voivodeship (Figure 1). Its area is 91.71 km<sup>2</sup>.



**Figure 1.** (a) Location of the research area against the background of Central Europe, the Lublin voivodeship, and the Łęczyński powiat; and (b) the division of the commune into mesoregions.

In terms of physiography, the territory of the commune is located within three mesoregions: Łęczna-Włodawa Lakeland, Świdnik Plateau, and the Dorohuczka Depression (Figure 1) [35].

The physiographic location of the commune significantly determines its geological and geomorphological structure, which in turn affects the agricultural suitability of soils. The northern part of the study area is dominated by river-periglacial sands, silts, and lake

clays with low peat areas in some places. The central-eastern part of the commune is covered with loess, and the central-western part is covered with lake sands, transitional peats, and silts of septic basins. In the south of the area, in the Mogielnica river valley, there are peaty muds adjacent to the river-periglacial sands of the floodplain terraces. The south-western part is dominated by lake sands and silts as well as transitional peats. Due to the hypsometry of the Puchaczów commune, there is mainly a flat type of surface relief with slight denivelations [36].

In terms of the usefulness of agricultural soils, the Puchaczów commune is quite diverse. The northernmost part of the commune is mainly occupied by medium grasslands. There are also weak, very weak, and strong grain and fodder rye complexes in this area. The north-central area consists mainly of very good and good rye complexes. The central-eastern part of the commune, located in loess, is made of very good and good wheat complexes. In the south-western part of the area there are medium, weak, and very weak grasslands. On the other hand, the south-eastern part of the commune is made up of very good and good rye complexes as well as a weak rye complex.

The above conditions of the natural environment significantly determine the type of land cover and, together with anthropogenic factors, shape the landscape of the commune [37].

A special feature that distinguishes the Puchaczów commune from other rural areas is the presence of hard coal deposits within its borders. The proper documentation of the raw material took place in the 1960s under the direction of Józef Porzycki [38]. This documentation contributed to the construction in 1974 of the first coal mine, “Bogdanka,” in the region. The area of the existing mining area of Puchaczów V is approximately 73 km<sup>2</sup>. It covers the area of three communes: Puchaczów, Cyców, and Ludwin. The estimated area of the mining area, i.e., the space covered by the possible harmful effects of mining works, is approx. 86 km<sup>2</sup>, and in the Puchaczów commune itself it is approx. 43.36 km<sup>2</sup>, which is 47% of its total area. It is worth mentioning that the industrial zone of the Puchaczów commune is located in an area with high natural values—Łęczna Lake District Landscape Park and its buffer zone (Figure 2).

The exploitation of hard coal in the region causes a number of changes related to the topography of post-mining waste dumps and subsidence troughs [39]. In addition, the operation of the Bogdanka mine is related to the presence of overground infrastructure in the commune’s landscape: a belt flyover of coal conveyors and pipelines (Figure 3). These elements, together with the industrial land development, are more important anthropogenic features of the Puchaczów commune and, at the same time, they are ecological barriers that have the greatest impact on the natural environment [40].

## 2.2. Materials

In the research presented in this article, the available cartographic materials were used: a topographic tactical map in the scale of 1:100,000, valid for the years 1937–1938 [41], a topographic map in the scale 1:50,000 in the PUWG 1965 system, showing the state of the area from the 1960s to 1970s, a vector map of level 2 (VMap Level 2) in the WGS-84 system in the 1:50,000 scale, valid for the years 1990–2000, and an orthophotomap (geoportal) presenting the status in 2020. In addition, in the spring and summer period in 2019–2020, field research was carried out to verify the cartographic data, and the applicable planning and strategic documents for the Puchaczów commune were analyzed. The collected cartographic studies differ in detail, and their selection was dictated primarily by their timeliness and availability for the above-mentioned time frames.

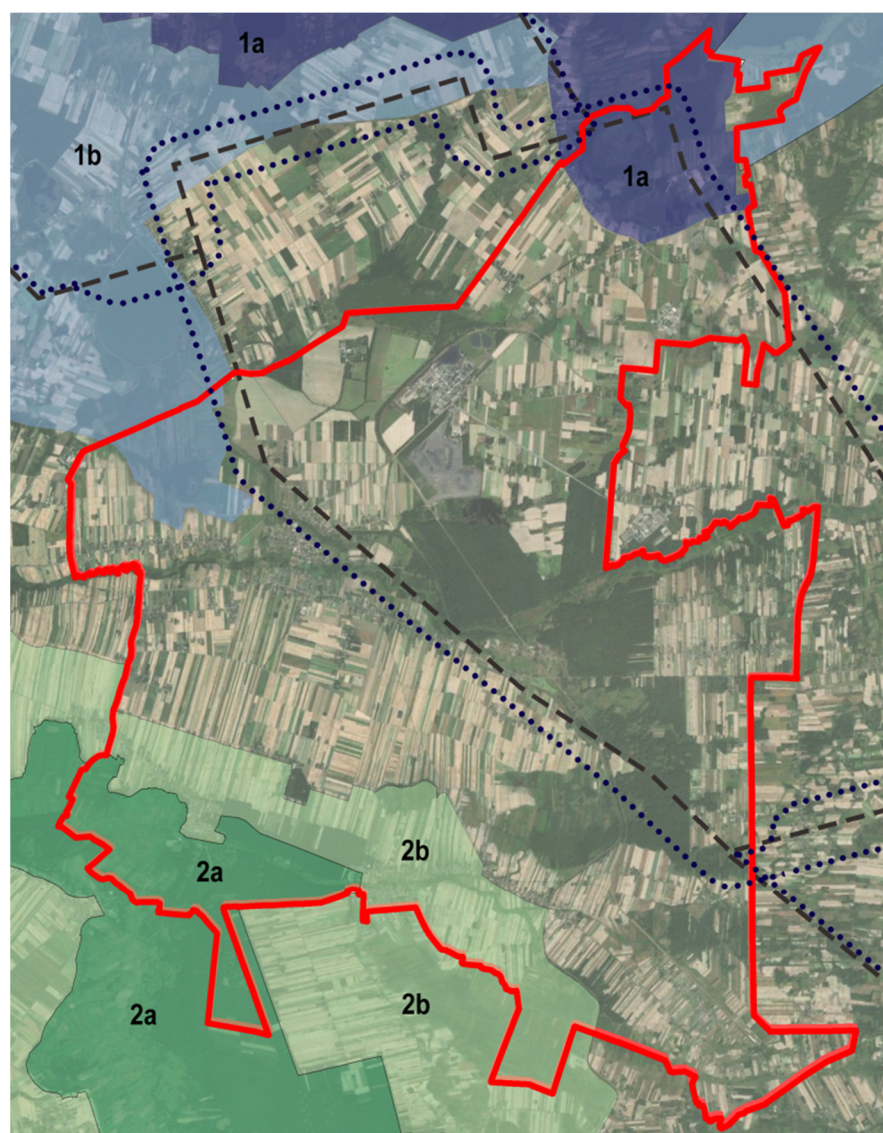
## 2.3. Methods

Research on changes in the rural landscape of the Puchaczów commune was divided into three stages. The first stage involved the delimitation of land cover units. This part of the work was done with ArcGIS [42]. The research identified seven main land cover units that could be identified:

1. Forest complexes and trees;



2. Meadows and pastures;
3. Agricultural land;
4. Compact settlement;
5. Industrial areas;
6. Road infrastructure;
7. Surface waters.



### Legend

- Commune boundary
- Border of the Mining Area
- Border of the Mining Region

0 0.5 1 2 3 4 Kilometers

**Figure 2.** Location of the mining area and the mining region in the Puchaczów commune, taking into account the location of landscape parks. (1a) Łęczna Lake District Landscape Park, (1b) Łęczna Lake District Landscape Park buffer zone, (2a) Nadwieprzański Landscape Park, (2b) Nadwieprzański Landscape Park buffer zone.



**Figure 3.** Overground belt flyover located by the road in the Puchaczów commune.

When distinguishing land cover units, the key that defined the criteria for the allocation of individual land use forms to a given cover unit was taken into account (Table 1).

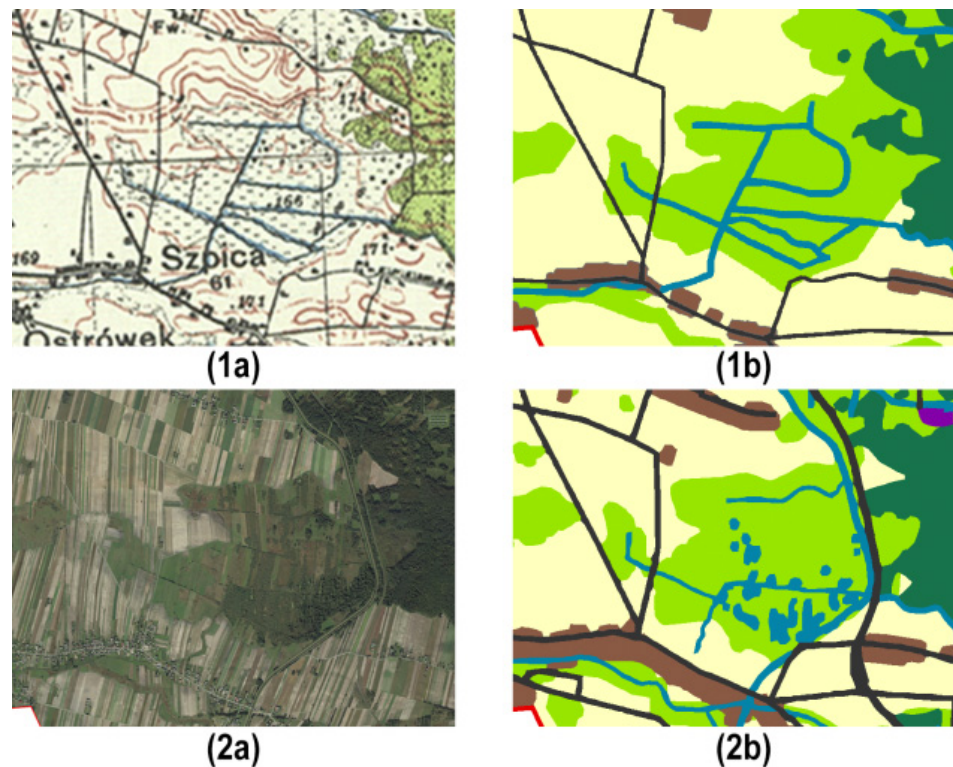
**Table 1.** Criteria for the allocation of individual land use forms to the coverage unit.

Land Cover Unit	Form of Land Use
Forest complexes and trees	Forests Forest clearings Bushes Parks
Meadows and pastures	Wetlands Fallow lands Meadows Pastures
Agricultural land	Farmlands Fruit orchards Areas of scattered farm buildings
Compact settlement	Compact housing development Compact service buildings
Industrial areas	Mining industry areas Mining heaps
Road infrastructure	Roads Railway lines
Surface waters	Lakes Rivers Other water reservoirs

The analysis of source materials has enabled the preparation and use of land cover diagrams, characterizing the functional and spatial structure of the commune in the years 1937–2020. It should be emphasized that the above land cover diagrams have been reduced to the same coordinate system (PUWG 1992). The term “land cover schemes” was used in the article on purpose, due to the fact that the data from topographic maps and orthophotos required cartographic interpretation and a heterogeneous scale of generalization (Figure 4).

The next stage of the work was to calculate the landscape metrics for the designated coverage units. The following indicators were used in the research: the percentage of individual land cover units, the average plot area, the number of patches making up a given coverage unit, the Shannon diversity index [43], and the Simpson diversity index [44]

(Table 2). The calculations were made with the program FRAGSTATS version 4.2 [45]. The above landscape metrics are included in the composition indicators and were selected because they very accurately and quantitatively reflect the transformation of the landscape of the Puchaczów commune, both in terms of changes in the size of individual units and the diversity of patches in the landscape. When selecting the indicators, the method of determining land cover units, which was determined by the quality and accuracy of source materials, was also taken into account. The last part of the research consisted in a comparative analysis of the values of the above indicators for the designated time frames in relation to changes in land use.



**Figure 4.** The way of interpreting data from source materials. (1a) fragment of the tactical map at a scale of 1:100,000 valid for the years 1937–1938 [32]; (1b) land cover diagram for the pre-war period; (2a) orthophotomap from 2020; and (2b) fragment of the land cover diagram for 2020.

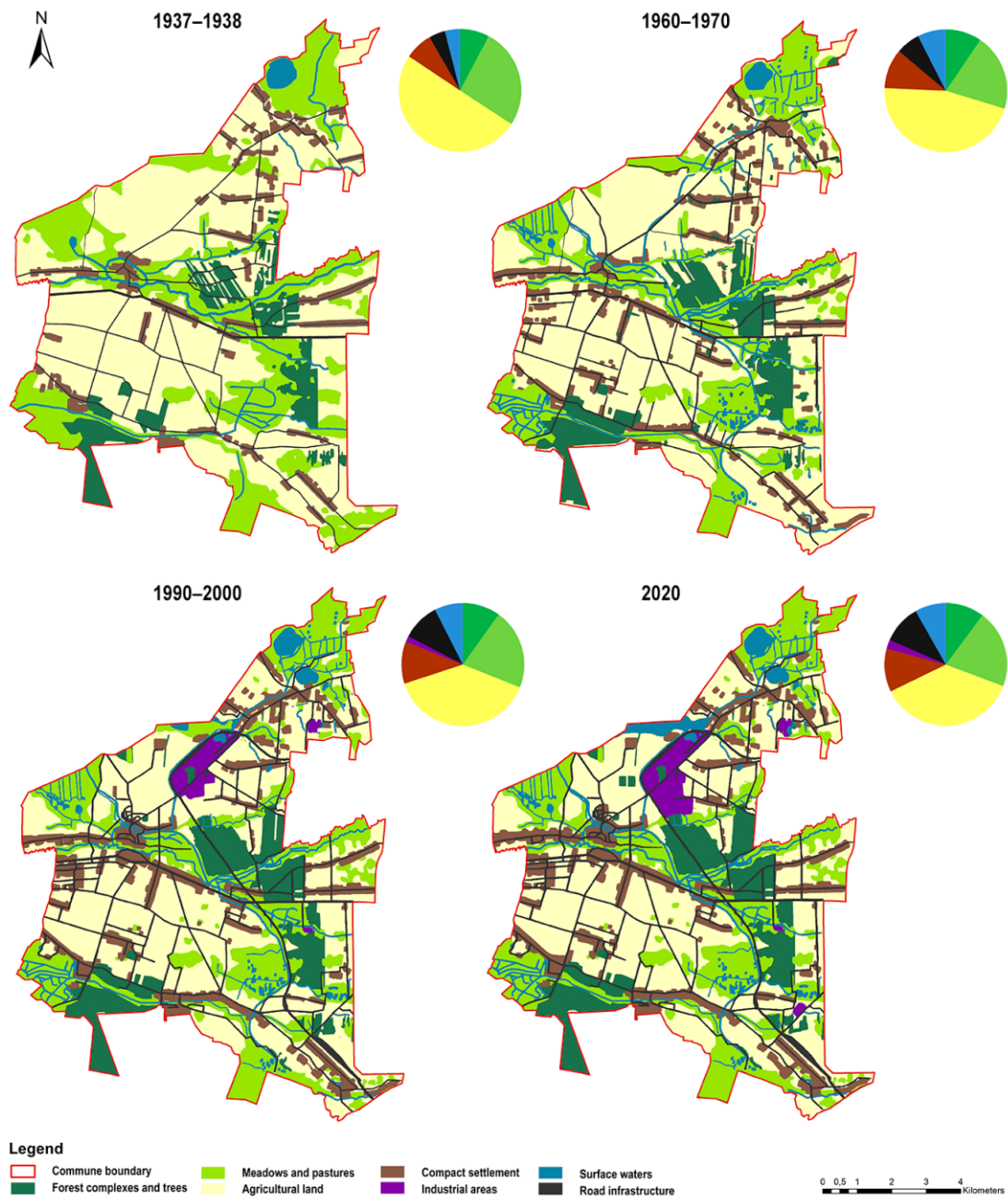
**Table 2.** Landscape metrics used in the study (comp. own based on [45]).

The Name of the Metric	Unit	Value Range	Characteristics
Percentage of landscape	[%]	$0 < \text{land} \leq 100$	The percentage share of the unit area in the landscape
Mean class area	[ha]	$0 < \text{MN}$	Average area size of the patches in a given unit
Number of patches	[number]	$0 < \text{NP}$	The total number of patches of the unit
Shannon's diversity index	[number]	$0 \leq \text{SHDI}$	The indicator is high with the increase in the number of patches and when the proportions of the terrain occupied by different classes of patches are equal
Simpson's diversity index	[number]	$0 \leq \text{SIDI} < 1$	SIDI increases as the number of different patch types increases and the proportional distribution of area among patch types becomes more equitable



### 3. Results

Schemes showing the functional and spatial structure of the Puchaczów commune in the years 1937–2020 are shown in Figure 5. Additionally, the figure presents the percentage of land cover in the form of a diagram. The values of landscape metrics for the Puchaczów commune are presented in Table 3.



**Figure 5.** Schemes of land cover in the Puchaczów commune for the pre-war period, 1960s and 1970s, 1990–2000, and 2020.



**Table 3.** Values of landscape metrics in the Puchaczów commune for the years 1937–2020.

The Name of the Metric	Land Cover Unit	Year			
		1937–1938	1960–1970	1990–2000	2020
Percentage of landscape	Forest complexes and trees	7.74%	9.50%	9.90%	10.17%
	Meadows and pastures	26.47%	20.17%	21.15%	20.57%
	Agricultural land	50.16%	46.06%	38.92%	37.05%
	Compact settlement	7.32%	10.44%	11.06%	11.39%
	Industrial areas	-	-	1.54%	2.34%
	Road infrastructure	4.31%	6.36%	9.95%	10.29%
	Surface waters	4.00%	7.47%	7.48%	8.19%
Mean class area [ha]	Forest complexes and trees	12.64	11.28	16.78	18.14
	Meadows and pastures	22.19	11.18	7.89	7.63
	Agricultural land	27.27	22.06	13.28	14.34
	Compact settlement	1.79	1.74	3.06	3.86
	Industrial areas	-	-	4.72	17.65
	Road infrastructure	131.59	193.38	303.59	468.11
	Surface waters	14.65	8.16	5.40	6.34
Number of patches	Forest complexes and trees	56	77	54	51
	Meadows and pastures	109	165	245	245
	Agricultural land	168	191	268	235
	Compact settlement	373	547	330	268
	Industrial areas	-	-	30	12
	Road infrastructure	3	3	3	2
	Surface waters	25	84	126	117
Shannon's diversity index		1.3523	1.5084	1.6561	1.6995
Simpson's diversity index		0.6638	0.7176	0.7660	0.7792

### 3.1. Functional and Spatial Structure in the Years 1937–1938

In the pre-war years, agricultural areas were the dominant form of land cover. They covered just over half of the area of the entire commune (50.16%). This unit was built of 168 patches, with an average size of 27.27 ha. The next in terms of land cover were the areas of meadows and pastures (26.47%). The meadows and pastures consisted of 109 patches with an average area of approx. 22.19 ha. Forest complexes and wooded areas accounted for 7.74% of the area and were built of 56 patches, with an average area of 12.64 ha. A similar percentage coverage was recorded in densely built-up areas (7.32%). However, compared to forest complexes, a large fragmentation of the spatial structure was observed in this unit. The number of patches was 373 and their average area was 1.79 ha. Road infrastructure accounted for approximately 4.31%, and surface water for approximately 4.00%.

### 3.2. Functional and Spatial Structure in the Years 1960–1970

In the 1960s–1970s, agricultural areas were also the dominant form of land cover, but compared to the previous years (1937–1938), their area decreased by over 4 percentage points. The structure of agricultural areas also changed, the number of patches included in a given unit increased to 191, and their average area decreased to 22.06 ha. In the described period, the percentage of the area covered by meadows and pastures decreased to 20.17%, with a simultaneous increase in the number of patches to 165. Interestingly, with the increase in the number of patches, their average area decreased to 11.18 ha. The area occupied by forest complexes and wooded areas increased to 9.50%, but as in the case of the above-mentioned units, the average area of patches decreased. On the other hand, in the 1960s and 1970s, there was an increase in the percentage of the area occupied by densely built-up areas (10.44%), road infrastructure (6.36%), and surface waters (7.47%). The reason for the transformation of water conditions in the Puchaczów commune was the construction of the Wieprz-Krzna canal in 1954–1961.

### 3.3. Functional and Spatial Structure in the Years 1990–2000

The period 1990–2000 brought another percentage decrease in the area occupied by agricultural land. Compared to the 1960s and 1970s, this value decreased by more than percentage points. The average area of the patches constituting the described unit of coverage also decreased (to 13.28 ha), with the simultaneous increase in the number of patches to 268. The above proves the progressive fragmentation of agricultural areas. In the case of other units, their percentage area increased. At that time, forest complexes and trees accounted for 9.90%, meadows and pastures 21.15%, compact buildings 11.06%, road infrastructure 9.95%, and surface waters 7.48%. Industrial areas are a new form of land cover, not present in earlier periods. In the last decade of the twentieth century, they occupied 1.54% of the area of the entire commune. The average size of a plot of this unit was 4.72 ha, with the number of patches equal to 30.

### 3.4. Functional and Spatial Structure in the Year 2020

In the year 2020 37.05% of the area of the Puchaczów commune is used for agriculture. The average area of the plot of this unit is 14.34 ha, which is almost half the value compared to the years 1937–1938. Currently, meadows and pastures constitute 20.57% of the area of the entire commune, and the average size of the patches is estimated at approx. 7.63 ha with the total number of patches equal to 245. This means that its structure was also fragmented within a given unit. It is worth noting that in the analyzed period there was an increase in the percentage area of forest complexes (10.17%), which, in relation to the previous years (1990–2000), is an increase in value by 0.27 percentage points. The average area of forest complex patches has also increased and currently amounts to 18.14 ha with 51 patches. Therefore, it should be concluded that in the case of forest complexes and wooded areas, the structure of the unit has merged. Data from 2020 show that dense development covers 11.39% of the commune's area. The average size of the patches is 3.86 ha, with a total of 268 patches. Along with the increase in the compact built-up area, the road infrastructure area increased to 10.29%. Areas with a dominant industrial function currently occupy 2.34%. Currently, the water area constitutes 8.19% of the commune, which in comparison to the years 1937–1938 gives an increase of over 4 percentage points.

### 3.5. The Diversity of the Commune's Landscape in the Years 1937–2020

When analyzing the Shannon and Simpson indices for the years 1937–2020 (Figure 6), a continuous increase in their value is noticeable, thus it should be concluded that there is an increase in the diversity of the landscape structure. This trend is expected to continue in the future. It is worth emphasizing, however, that the dynamics of the landscape transformation process are variable. The greatest increase in diversity in the functional and spatial structure of the commune took place in the periods 1937–1938 and 1960–1970. This was due to the intensive development of densely built-up areas and communication infrastructure, that took place after the Second World War and the construction of the Wieprz-Krzna canal, which significantly transformed the water relations in the commune and changed the way land was used. A slightly smaller difference occurs between the values of the indicators in the periods 1960–1970 and 1990–2000. This smaller difference means that the emergence of a mining function in the commune did not increase the diversity of the landscape as much as one might suppose. This lack of increase is due to the small area occupied by industrial areas in relation to the area of other coverage units. Interestingly, after 1990–2000 the intensity of the process of changes in the way the commune is managed slowed down. The key to this slowing seems to be Poland's accession to the European Union and the adopted regulations concerning spatial and agricultural policy (including the Common Agricultural Policy).

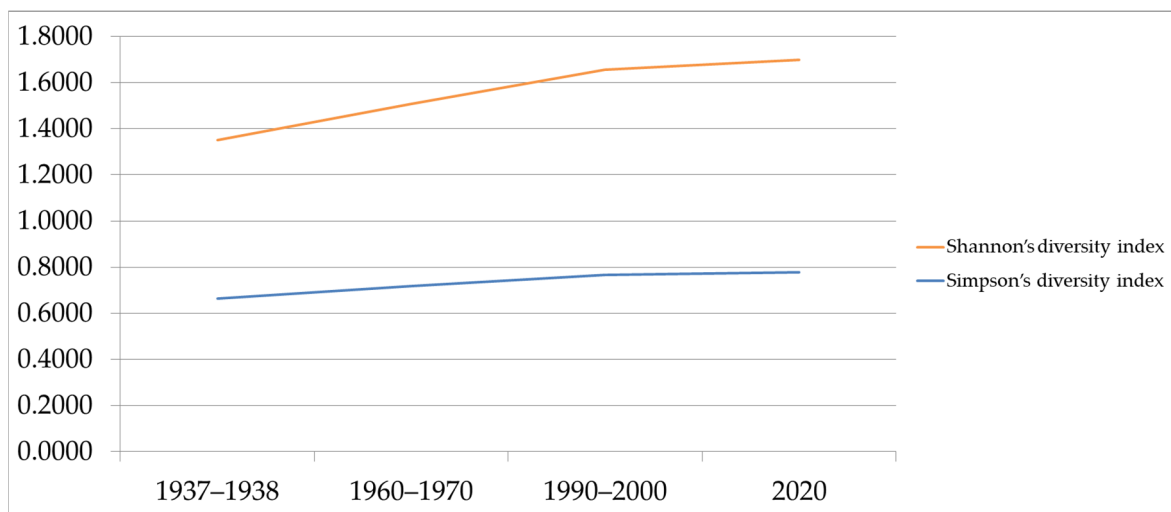


Figure 6. Growth dynamics of the diversity indexes.

#### 4. Discussion

Landscape metrics are commonly used to quantify changes in landscape, including in rural areas. However, there are some limitations to the use of landscape metrics, which result from the degree of their dependence on the quality of source materials [46–48]. The value of the indicators depends on the generalization of data from cartographic studies and is related to the interpretation of the shape of the lobes and the simplification of their surface [17,49,50]. Nevertheless, landscape indicators remain important in terms of monitoring the evolution of the landscape. By adopting the same method of determining the terrain coverage units, taking into account the same generalization of data resulting from the source materials, the metrics allow the main character of the transformations of the functional and spatial structure of the studied area over the years to be described. It is worth emphasizing that the use of more indicators in the research allows for a more complete picture of these transformations. Landscape metrics should always be selected according to the purpose and scope of the research.

In the case of the Puchaczów commune, the influence of land cover units on the region's development process does not depend on the size of their area. Currently, the industrial area accounts for slightly more than 2% of the land cover, but its impact on the landscape of the commune is enormous. As emphasized both in the local development strategy of the Puchaczów commune for the years 2007–2015 [51] and in the study of the conditions and directions of the commune development [39], in the natural environment, the most visible transformations caused by hard coal mining took place in the natural terrain. Mining activity causes quantitative and qualitative changes in the hydrosphere and increases the pollution of surface waters, e.g., as a result of mine sewage discharge [39]. The above transformations of water ratios result in changes in the agricultural production space. The transformations first affect plant communities, and then fauna. Industrial areas are also the main emitter of atmospheric air pollutants in the Puchaczów commune, which is particularly dangerous in the times of current climate change. This proves that the assessment of landscape transformation based on the comparison of landscape metrics for different periods requires supplementing with the analysis of the impact of coverage units on the environment, tailored to the individual characteristics of the studied area.

According to Pukowiec-Kurda and Sobol [17], the Shannon diversity index reaches higher values with an increase in the degree of anthropogenic transformation of the landscape. In the Puchaczów commune, this indicator in the years 1937–1938 was 1.3523, and in 2020 it increased to 1.6995. It should therefore be stated that over the years the landscape of the commune has changed significantly as a result of human activity. It is worth noting that the greatest increase in the value of the Shannon index was recorded between the pre-war

period and the 1960s–1970s. This means that the dynamics of changes in the described time frame were also the highest. Similar results are presented by the Simpson index, which takes into account the proportions of the surface distribution between the classes of airfoils. The largest difference between the values of a given metric also occurs for the years 1937–1938 and 1960–1970. It should be noted that the emergence of a new form of land development (mining industry) did not significantly affect the value of both diversity indicators.

## 5. Conclusions

The comparison of landscape indicators of the Puchaczów commune presented in the article proves that the functional and spatial structure of the village is constantly undergoing transformation. In the Puchaczów commune, in the years 1937–2020 there was a decrease in the area occupied by agricultural land, meadows and pastures. Despite this, agricultural production remains the dominant function in the study area. Currently, the basis for the development of the Puchaczów commune is the mining industry, which, despite occupying a small percentage of the entire commune, significantly influences the transformation of the rural landscape. An important task faced by the commune after the exploitation of hard coal resources is to maintain a high level of development of non-agricultural activities combined with the process of restoration of post-industrial areas. The direction of land development, which appears as a prospect for further development of the commune, is tourism.

Due to the dominant contemporary land use, the Puchaczów commune can be divided into the northern part, where the main branch of the economy is mining, and the southern part related to agricultural activities. Forest complexes and areas of meadows and pastures located in the central part of the commune constitute a buffer element between the above-mentioned zones, therefore, an important issue is these nature structures appropriate shaping and strengthening.

When analyzing the values of landscape metrics calculated for the purposes of the above-mentioned studies, it can be noticed that the landscape diversity increased in the Puchaczów commune, but the dynamics of this process itself was not related to the emergence of the mining industry.

Landscape metrics provide an appropriate basis for quantifying changes in rural areas. However, it is only in conjunction with research on the method of interaction of coverage units that enables a more complete picture of the nature of landscape transformations to be obtained.

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