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Analysis of Regulatory Possibilities and Obstacles to Expand Renewable Energy and Preserve Landscape Quality in the Silesian Voivodship

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Abstract: Current international works on strategies for climate change mitigation and adaptation cite energy transition as one of the main challenges of the 21st century. Many social, economic, and ecological aspects have to be addressed, especially in regions which, for decades, relied on coal energy. One of those are changes in spatial planning and land use, which will significantly affect the landscape of those regions. One of these examples is Silesian Voivodship in Poland, where the coal-mining tradition dates back to the 17th century. This research focuses on the question of how and where renewable energy development is planned in the Silesian Voivodship, based on provisions from local spatial polices and to what extent post-mining and industrial sites are planned to be reused and how many other types of landscapes would be transformed into renewable energy landscapes. We argue that permitting development of renewable energy (RE) without appropriate regulations on where and how it should be developed may contribute to irreversible changes in the landscape and, as a result, to its degradation. Methods consisted of query and analyses of available publications, datasets, strategy and planning documents, both at regional and municipal level. The main results show that existing renewable energy and its development is mainly planned away from mining and post-mining industrial areas. In the future, this will have a significant impact on the transformation of, e.g., rural, natural and agricultural landscapes into new industrial energy landscapes, changing views and perception of these places.

Keywords: energy landscapes; coal regions; energy transition; photovoltaics; wind energy

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1. Introduction

The use of renewable energy technologies, in particular wind and photovoltaic (PV) systems, is a key pillar of European climate change policy [1]. According to the State of the Energy Union 2021—Contributing to the European Green Deal and the Union's recovery Report [2] in 2020, renewables overtook fossil fuels for the first time in the EU, generating 38% of electricity (compared to 37% for fossil fuels). However, in many countries, including Poland, the share of renewable energy in the energy mix is still small. Currently in Poland, power generation from coal is predominant (64.95%). Similar situation can be observed in the Czech Republic (62.16%) and Slovenia (42.83%). However, these countries have almost twice the share of renewable energy in their energy mix than Poland (23.3% Czech Republic, 21.68% Slovenia, 12.7% Poland) [3]. The benefits of renewable energy for environment, society, and the economy have been acknowledged for a long time, despite many advantages of renewable energy sources (RES) their negative impacts are also reported [4]. One of them, which has become more and more important recently, is the impact on the landscape [5].

Transition to renewable energy sources is inseparable linked to the availability of land for renewable energy infrastructure, which require more surface area to produce an equivalent amount of power as from fossil fuels [6–8]. This high land demand arise

negative impacts on the landscape [9]. This impact vary according to the RES type, the context and scale of development [10], the landscape type, perceived naturalness, and landscape aesthetic value [11]. RES can affect the landscape by transforming land use and/or by reshaping the visual character of the landscape. The land use impact is the most important concern for on-ground photovoltaic farms, and the visual impact is most noticeable for wind energy facilities development [5]. The impact of RES on landscape quality brings specific challenges for energy planning to avoid the degradation of landscape quality [5]. Defining siting requirements for renewable generation and transmission, and recognizing particularly sensitive areas excluded in advance from RES development, can help municipalities to deal effectively with developers and can prevent the negative impacts of RES facilities development [12]. Nowadays, people are becoming more aware that among other elements of the environment not only pollution of air or water is affecting their quality of life but the landscape is also important for human well-being. It is important especially in densely populated Europe, where energy landscapes are even more visible by many users, than in any other part of the world [13]. Considering how NIMBY phenomenon slows down the process of energy transition from coal to renewable, it is important to understand that landscape has to be seen as a resource that, in general, is heavily exploited in the energy production process. Therefore, to improve the process of sustainable transformation it has to be politically more visible [14]. There is a clear need to carefully locate wind and PV farms to minimize their visual impact [15]. Many landscape and visual impacts of wind and PV farms could be minimized by the appropriate selection of design, layout, and location, by avoiding their visibility from sensitive viewpoints [10].

An important tool in the implementation of the renewable energy development policy, and a key step in finding sustainable solutions for RES projects is spatial planning [16]. Sustainable energy landscape planning and designing, where landscape architects and urban planners are engaged in the process of implementing energy production facilities from the beginning, may help to create a positive experience for landscape users. Specific provisions in spatial plans that include character of existing cultural landscapes, limitations towards parameters of the facilities, such as their height, number, spacing, color, and spatial arrangement, are crucial in this case [17–19]. On the one hand, it helps to maximize the wind and solar energy potential in an area and, on the other hand, to simultaneously achieve environmental protection (including human population and natural heritage) in the same space [20]. Spatial planning is also a powerful tool that can be used to find ways of reusing land that has become redundant, e.g., because of land contamination or sunset industries [21]. In the whole system of elements, the role of planning is to reconcile specific conditions by introducing spatial order. The purpose of planning is to protect the quality and value of space.

The development of RES investments involves trade-offs in terms of spatial sustainability, e.g., between minimizing energy system costs, mitigating impacts on people, landscape and biodiversity [8]. However, the use of RES may provide an alternative for the development of post-industrial, post-mining, and poor-quality agricultural land. New energy sources represent an opportunity for the rehabilitation of degraded environments and to design new forms of landscape [12,22]. PV farms can be used for conversion of brownfields in a productive landscape [5]. Landscapes that previously contained large technical installations (e.g., mining or harbor areas) can more easily assimilate RES, due to thematic association with industrial structures [10]. Wind turbines and PV installations can be used to temporarily discourage other developments, e.g., increase of suburbs [13]. Renewable power can also be co-located with other land uses, such as solar generation on city rooftops and wind and solar facilities sharing land with agriculture [12]. In Poland, as in Europe, wind energy has the largest share among renewable energy. Another RES, in terms of installed capacity, is photovoltaics, which, thanks to its dynamic development, may overtake wind energy in the coming months [23]. The share of energy from renewable sources in the total primary energy production in Poland is growing and, in the years 2014–2018, increased from 12.12% to 14.46%. However, still around 80% of electricity in

Poland is still generated from coal [24]. The most coal-dependent region in Poland is the Silesian Voivodship. At the same time it is the region with one of the lowest proportions of energy production from renewable sources. The biggest challenge in energy transition in the Silesian Voivodship is the strong legacy of coal in the region. Mines are still one of the biggest employers in the region, and the miner community is one of the most powerful professional groups of employees in the country. That, unfortunately, means that aspects of climate change and obligations towards the European Union Green Deal goals are hard to achieve, even though Poles understand that modernization of the energy sector is crucial to improving the energy security of the country [25,26]. However, when finally started, the process of energy transition will affect the Silesian Voivodship landscape, just as the development of coal-based energy has changed it in previous centuries.

In Poland, there are very general rules regarding the location of renewable energy installations and no direct regulations for landscape protection in Polish legal system There are some limitations regarding the proximity of housing resulting from the so-called Distance Act of 2016; limitations related to distancing from forms of nature protection areas resulting from Act of Nature Protection of 2004 and cultural landscapes in Act on Monuments Protection and Maintenance of 2003. Other than this, cultural heritage protection zones are established on a local level in local spatial development plans [27]. There are also no specific guidelines for renewable energy spatial planning and introduction to the landscape. Additionally, in SEA and EIA, required by the Act of 2008 on the provision of information on the environment and its protection, public participation protection, public participation in environmental protection, and environmental impact assessment procedures, landscape character is not taken into account when assessing the impact of the energy investments [28]. A lack of regulatory frameworks means that spatial planning on a local level determines the impact of renewable energy development on the landscape in the most specific way.

The detailed development of the RES is usually specified at this level and is regulated by spatial planning documents, so we decided to look there for the provisions for landscape protection as they are required in, e.g., Studies of Conditions and Direction of Spatial Development for cultural landscapes or nature conservation areas.

The main goal of this research was to explore the provisions of local spatial policies of the Silesia Region municipalities to provide a comprehensive overview on extension of RE landscapes in this area. We were interested in the extent to which landscapes already heavily transformed by coal-fired energy production are planned to be used, and the extent to which the energy transition will cause further transformation of other types of landscapes to those associated with renewable energy sources.

We consider that permitting renewable energy development, without appropriate regulations on where and how it should be developed, may contribute to irreversible changes in the landscape and, as a result, to its degradation. These regulations should be included in spatial planning documents, which are one of the most important tools for landscape protection. Special attention should be paid to municipal spatial policies as the local self-government in Poland have the decisive influence on how the land will be developed.

2. Study Area

2.1. General Characteristics of the Silesian Voivodship

The Silesian Voivodship is one of the 16 regional I tier units of administrative division of Poland. Voivodships coterminous with NUTS-2 units (with the exception of Mazovian Voivodship, which is split into two NUTS units). The Silesian Voivodship borders correspond to NUTS-2 PL22. The voivodship covers an area of 12,333 km^2, i.e., 3.9% of the of the national territory. Administrative structure of the voivodship consists of poviats (II tier units which do not have equivalents in NUTS units) and municipalities (III tier units which coterminous with LAU units). There are 36 poviats in the Silesian Voividship, including 17 rural poviats (which consists of rural areas and smaller towns) and 19 urban

poviats (cities with poviat rights, i.e., with more than 100,000 inhabitants or/and cities located in large urban agglomerations). In total, 167 III tier units are grouped in three types of municipalities: urban, which comprises cities (49); urban–rural, which comprises towns with the surrounding countryside (22); and rural, which comprises countryside (96). The breakdown by type of municipality differs from the DEGURBA classification. It is based on the criterion of the size of the unit in terms of population and employment of inhabitants. Thus, an urban municipality must have at least 2000 inhabitants, at least two-thirds of whom are not working in agriculture. Table A1 in Appendix A shows the municipalities of the voivodship with the DEGURBA and LAU Eurostat codes, as well as its area and population.

The Silesian Voivodship is inhabited by 4.5 million people, which is 11.8% of Poland's population. It is the most urbanized region of Poland (76.7% of the of urban population) with the highest population density (368 persons/km^2, with national average of 123 persons/km^2). In the land use structure of the voivodship, agricultural land dominates, making up 50.9% of its total territory, and is followed by forests (32.8%).

The Silesian Voivodship, despite the fact that it is regarded as one of Poland's most anthropologically transformed areas, has many valuable natural and cultural assets. Areas covered by different forms of nature protection constitute almost 34% of the voivodship area; they are: 8 landscape parks, 65 nature reserves, 15 landscape protected areas, 81 ecological sites, 22 nature–landscape complexes, 11 geological sites, and 1455 nature monuments. The Silesian Voivodship is an area with a unique, diverse, and rich cultural heritage. They are of particular importance in preserving the identity of the region and shaping the economic and tourist attractiveness of the voivodship. The register of monuments in the Silesian Voivodship includes 2702 immovable monuments, including those relating to the coal-legacy.

The Silesian Voivodship is divided into four subregions (which differ for functional and landscape reasons): northern (covering an area of 3049 km^2), southern (2354 km^2), central (5577 km^2), and western (1353 km^2). The boundaries of the northern, southern, and western subregions correspond to the boundaries of the NUTS-3 units. The southern subregion coincides with PL224 (Częstochowski), the southern subregion with PL225 (Bielski), and the western subregion with PL227 (Rybnicki). The central subregion includes five NUTS-3 units: PL228 (Bytomski), PL229 (Gliwicki), PL22A (Katowicki), PL22B (Sosnowiecki), and PL 22C (Tyski). The largest sub-region of the voivodship, the central one, is inhabited by 2.72 million inhabitants (i.e., 60% of the region's population). It is the most industrialized region in Poland. Northern and southern subregions are characterized by the highest proportion of rural areas (85.8% and 80%, respectively).

These areas also have the highest percentage of population who living in rural areas (42.2% and 50.5%, respectively). The south subregion is characterized by high tourist attractiveness. It is the mountain area, known for its diversity of cultural and natural landscapes, which makes it attractive all year round. Figure 1 presents the administrative structure (a) and population density (b) of Silesian Voivodship.

2.2. Current Stage of Renewable Energy Development in Silesian Voivodship

According to the Report "Renewable Energy Sources Installations—state as of 31 December 2020" [29], there were 31 individual wind power plants with a total capacity of ca. 37.5 MW in the Silesian Voivodship in December 2020. Most wind power plants were built in the northern part of the voivodship in the following rural poviats: częstochowski (10), lubliniecki (9), kłobucki (7), and in the urban poviat Częstochowa (1). In the southern part of the voivodship wind power plants are located in the raciborski (3) and gliwicki (1) rural poviats. None of the mentioned power plants were established in mining or post-mining areas, which are mainly located in the central part of the voivodship. This is strictly related to the fact that the best conditions for the development of this type of power plants are in other parts of the voivodship.

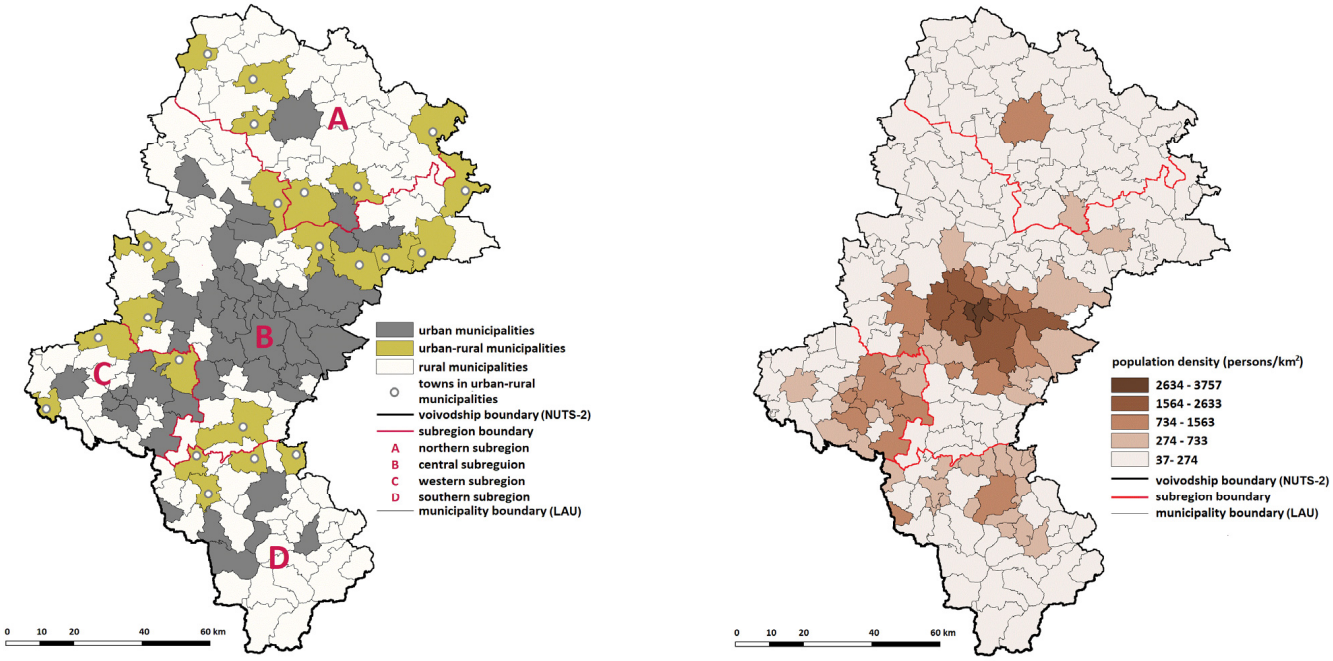


Figure 1. Administrative structure (**a**) and population density (**b**) of Silesian Voivodship (source: own elaboration based on Statistical Yearbook of Silesian Viovodship 2020).

In contrast, photovoltaic farms were more dispersed throughout the voivodship. The report indicates that in December 2020 there were 171 photovoltaic farms operating with a total capacity of 17.65 MW. Most of them were located in urban poviat Katowice (17) and cieszyński (17), częstochowski (13), bielski (13), and żywiecki (9) rural poviats. Other photovoltaic power plants were located in the following rural poviats: będziński (5), bieruńsko-lędziński (6), gliwicki (7), kłobucki (5), lubliniecki (6), myszkowski (4), pszczyński (3), raciborski (1), rybnicki (1), tarnogórski (3), wodzisławski (2), zawierciański (5), and in urban poviats: Bielsko-Biała (4), Bytom (3), Chorzów (4), Częstochowa (4), Dąbrowa Górnicza (2), Gliwice (9), Jastrzębie-Zdrój (10), Jaworzno (2), Piekary Śląskie (1), Ruda Śląska (3), Rybnik (3), Siemianowice Śląskie (5), Sosnowiec (5), Tychy (2), Zabrze (8), and Żory (1). Special attention should be paid to the fact that more photovoltaic power plants are located in the cities of Silesian agglomeration in contrast to wind energy. Thus, in the case of photovoltaics there is an example of an installation which was located in industrial areas connected with coal-mining. It was installed on the premises of the Halemba mine in Ruda Śląska. It consists of 1109 photovoltaic cells with a capacity of 410 kWp placed on the roofs of nine buildings of the mine [30].

2.3. Transition to Renewable Energy—Development Directions from the Regional Perspective

There are two main documents which shape future plans for spatial development of the Voivodship: Strategy of the Silesian Voivodship Development „Śląskie 2030" [31] and Spatial Development Plan od the Silesian Voivodship 2020 + [32].

Table 1 presents differences in aspects covered in the documents above.

According to both of these documents, mining is still one of the most important branches of the economy of the Silesian Voivodship and this has also a great spatial impact on the landscapes of the region. Strategy of the Silesian Voivodship Development "Śląskie 2030", indicated that 24 municipalities have spatial problems related to the transformation, where management of closed mining exploitation areas is a significant problem that needs to be solved. Both of the documents mentioned that, due to the process of restructurization of economy this, however, started to change recently. Even though Silesian Voivodship is

still in the beginning of the process and percentage of renewable energy investments is the lowest in the country, strategy for transition from coal to renewable is widely planned in whole area of this region, which is described in the above-mentioned documents.

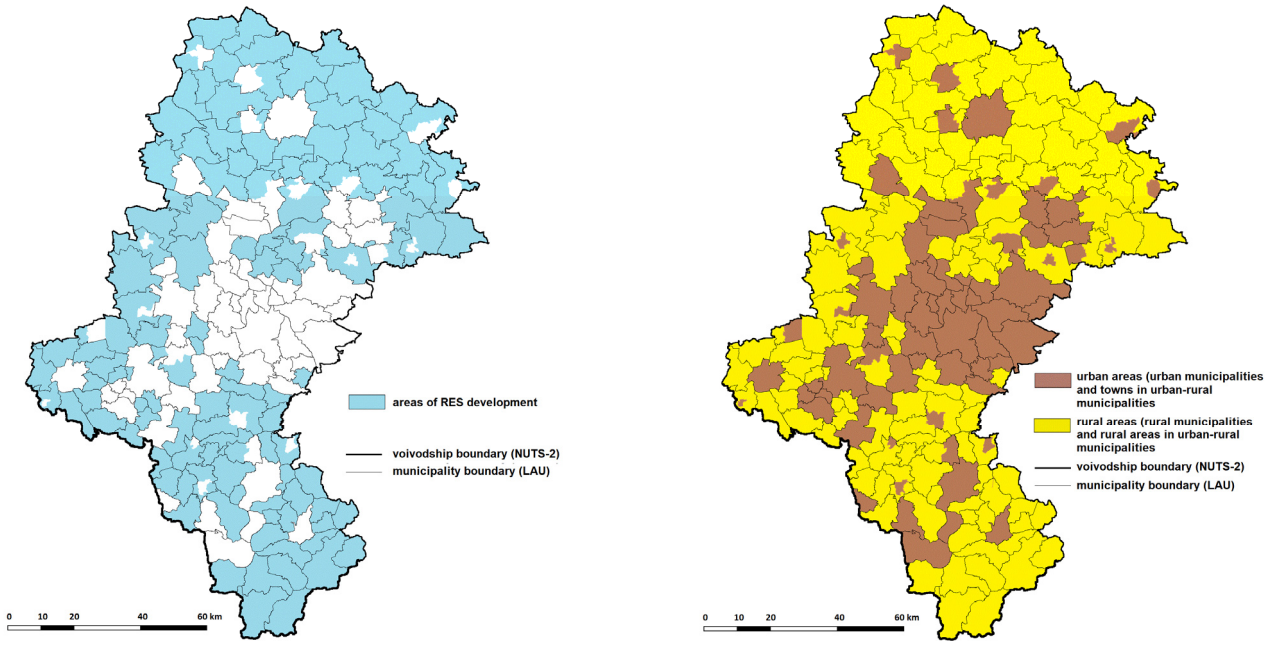
Table 1. Plans for renewable energy development according to Strategy of the Silesian Voivodship Development "Śląskie 2030" and Spatial Development Plan od the Silesian Voivodship 2020+.

Aspect of Spatial Development of Renewable Energy Characterized in the Document	Strategy of the Silesian Voivodship Development "Śląskie 2030"	Spatial Development Plan of the Silesian Voivodship 2020+
Plans for further renewable energy development	+	+
Localization of renewable energy facilities in the voivodship	-	+
Allowed types of renewable energy facilities	-	+
Land use type for renewable energy development	-	-

The first document, Strategy of the Silesian Voivodship Development "Śląskie 2030", describes only the general need of renewable energy development in the Silesia Voivodship. There are no provisions related to spatial distribution of renewable energy facilities, preferred renewable energy type, and type of the land use where renewable energy infrastructure should develop. The Strategic Environmental Impact Assessment of this document [33], however, draws attention to such aspects of the development of renewable energy as negative impact on the landscape, soil degradation, and transformation of the earth's surface in connection with the construction of installations based on energy from wind, sun, and water, especially in, or close to, nature protection areas but this influence would only be local.

The second document, Spatial Development Plan of the Silesian Voivodship, focuses on the need for distributed energy development based on the construction of small generating units in places best suited to use specific environmental resources such as, for example, water, wind, or solar. According to this document, there are average conditions for renewable energy development in this region, with only exception for biomass energy and biogas, which can be perceived as high. In general, the areas indicated for wind energy development concern mainly rural areas. Figure 2 presents areas of renewable energy development according to Regional Spatial Development Plan (a) vs. urban and rural areas in the voivodship (b).

To sum up, the provisions of these documents are very general and limited in terms of sitting and parameters of renewable energy facilities. There are also no specific provisions for land use type where renewable energy objects could be implemented and encouragement for the use of already degraded post-mining landscapes.



(**a**) (**b**)

Figure 2. Areas of renewable energy development according to Regional Spatial Development Plan (**a**) vs. urban and rural areas in the voivodship (**b**) (source: own elaboration based on Regional Spatial Development Plan and Statistical Yearbook of Silesian Voivodship 2020).

3. Materials and Methods

In our research, we focused in particular on two types of renewable energy installations that specifically alter landscape character, i.e., wind and photovoltaic farms. To estimate the extent of further development of renewable energy in Silesian Voivodship, basic spatial planning documents applied at municipal level were analyzed, i.e., Studies of Conditions and Directions of Spatial Development of Municipality. In the spatial planning system in Poland, these documents are mandatory, and determine the directions of change in the spatial structure and in the land use. We applied a document analysis method using the READ approach—a systematic procedure for collecting documents and gaining information from them [34]. In line with the method adopted, our research involved four steps: (1) ready materials, (2) extract data, (3) analyze data, and (4) distil findings.

In step one, we tried to collect the Studies of Conditions and Directions of Spatial Development for all the municipalities in the Silesian Voivodship. Analyzed documents were obtained from the public information bulletin of municipalities. In total, Studies for 133 out of 167 municipalities of Silesian Voivodship were analyzed. Documents for 20 municipalities were not publicly available and 14 municipalities were in the process of amending the Study.

To extract data, we used an Excel spreadsheet where we have collected equivalent data for each document. We checked whether and in which of the municipalities the locations of new RE facilities are planned, and then if they are related to wind energy and photovoltaic energy in particular. This way it was verified whether the provisions are in line with the voivodship plan. It was also checked whether these were mainly municipalities, whose landscapes were already heavily industrialized due to the coal-mining infrastructure located there, or whether renewable energy would be developed in new areas, in municipalities with different landscape features. At the same time, it was checked which of the two types of renewable energy is more favored for development in each municipality. It was then checked whether the studies make a distinction for the development of wind and photovoltaic energy based on the capacity of the installation.

In the third part of the research, we analyzed on which types of land use the development of wind and photovoltaic farms is most often planned, and whether the municipalities, in their studies, designate zones for renewable energy sources development, including wind and solar ones. It was also checked whether the municipalities define specific parameters for these zones related to renewable energy development in particular. It was examined how detailed the municipal studies set out the parameters for renewable energy development affecting the perception of the landscape in which renewable energy facilities will be located, including issues relating to the type of installation and its appearance, the length of time for which it is to be installed, ageing infrastructure, decommissioning, and repowering. This was particularly important in view of the scale of potential transformations associated with renewable energy development.

Additionally, in this part of the research, it was investigated whether cultural landscapes of Silesian Voivodship, including heritage and historic monuments related to mining, limit the development of renewable energy in municipalities where they exist and if they were protected from the negative impact of these changes by the provisions in the analyzed studies. It was also verified whether historic areas related to coal-mining are planned for energy transition and renewable energy development. In the same part, it was analyzed whether renewable energy development is planned in municipalities with any legal form of nature protection established to protect unique and valuable landscapes. It was also checked whether the studies contained any provisions regarding protection of these areas from the possible negative impact of renewable energy facilities.

We assumed that in order to distill findings and thus achieve the research objective and predict the impact of the energy transition of Silesian Voivodship on the landscape, by analyzing the provisions of the Studies of Conditions and Directions of Spatial Development for each municipality, we should answer the following questions:

1. What is the spatial extent of renewable energy development, and which municipalities are favored in this respect?
2. What types of land use are designated for renewable energy development, and what are the specific provisions for RE facilities?
3. Are valuable natural and cultural landscapes protected from the negative impacts of renewable energy development by specific provisions of Studies of Conditions and Directions of Spatial Development?

As a result, this has helped us determine to what extent the regulations contained in municipal planning documents will support landscape protection in the energy transition process.

4. Results

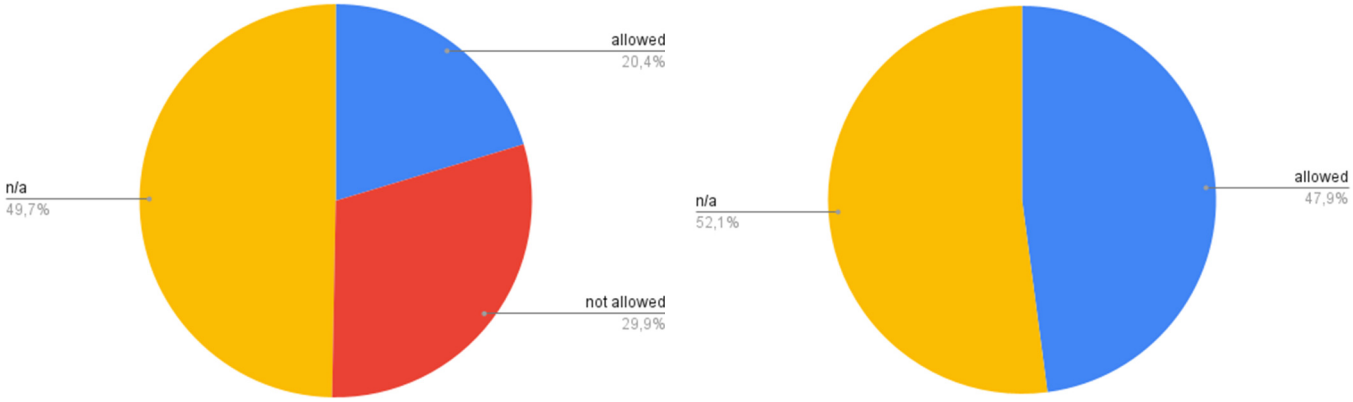
4.1. General Provisions for Renewable Energy and in Particular Wind Energy and Solar Energy Development in Studies of Conditions and Direction of Spatial Development

In general, renewable energy development was planned in 115 out of 133 analyzed studies.

Results of this part of the study show that development of renewable energy based on wind energy is usually more restricted than other types of renewable energy. Research of the Studies of Conditions and Directions of Spatial Development showed that only 34 out of 167 municipalities planned development of wind farms. Figure 3a presents the percentage of municipalities where further development of wind energy is allowed. Even though legal regulations in Poland for wind energy below 100 kW are less restrictive, only eight municipalities indicated locations for the development of wind energy below 100 kW. At the same time, 15 municipalities indicated locations for development of wind energy above 100 kW. These numbers do not include existing power plants. In some cases, such as in Opatów, further development of wind energy is not allowed due to a lack of space needed for buffer zones around each wind turbine. Establishment of these zones, where housing is forbidden, has been required since 2016 due to the, so-called, Distance Act.

Construction of photovoltaics is planned in 80 out of 167 municipalities. Figure 3b shows the percentage of municipalities where further development of solar energy is al-

lowed. Although, in some cases, it is not explicitly described that development of solar energy facilities is allowed, it can be assumed that it is one of the many types of renewable energy facilities that can be developed apart from wind energy. Studies of 15 municipalities indicated locations for the development of photovoltaics in micro-installations or below 100 kW. At the same time studies of 61 municipalities indicated locations for the development of photovoltaics above 100 kW.



(**a**) (**b**)

Figure 3. Percentage of municipalities where further development of wind energy is allowed (**a**). Percentage of municipalities where further development of solar energy is allowed (**b**) (source: own elaboration based on Studies of Conditions and Directions of Spatial Development of Silesian Voivodship municipalities).

4.2. General Character of the Municipalities Where Renewable Energy Based on Wind and Solar Energy May Be Developed

As it was mentioned in Section 2.1 General Characteristics of Study Area, in the Silesian Voivodship there are 96 rural municipalities, 49 urban municipalities and 22 urban–rural municipalities. In this research, we analyzed 74 rural municipalities, 43 urban municipalities, and 16 urban–rural municipalities. Research shows that 63 studies of rural municipalities, 14 studies of urban–rural municipalities, and 38 studies of urban municipalities have provisions for renewable energy development. According to the analyzed studies, wind energy development is planned mainly in rural municipalities (19), mainly in the northern part of the voivodship. It is also allowed in seven urban–rural municipalities and in four urban municipalities. Solar energy development on the other hand is allowed in 42 rural municipalities, 28 urban municipalities, and 10 urban-rural municipalities. Figure 4 shows rural, urban, and urban–rural municipalities of the Silesian Voivodship with provisions for renewable energy development.

If we look into other types of classifications of municipalities of voivodship, we can notice that, in general, renewable energy may be developed in 45 out of 60 municipalities that are classified as mining municipalities [35], in 37 out of 45 typically industrial municipalities where over 80 ha consists of industrial area [36] and in 36 out of 52 municipalities with an extensive agriculture—High Nature Value Farmland [37]. Wind energy development is allowed in 10 out of 60 mining municipalities, 10 out of 45 industrial municipalities (9 of these municipalities overlap), and in 12 out of 52 municipalities with extensive agriculture. Solar energy development is allowed in 30 mining municipalities, 24 industrial municipalities (18 of those municipalities overlap), and in 22 municipalities with extensive agriculture. Figure 5 shows provisions for renewable energy development in Studies of Conditions and Directions of Spatial Development in spatial relation to (a) mining, (b) industrial, and (c) extensive agriculture municipalities of Silesian Voivodship.

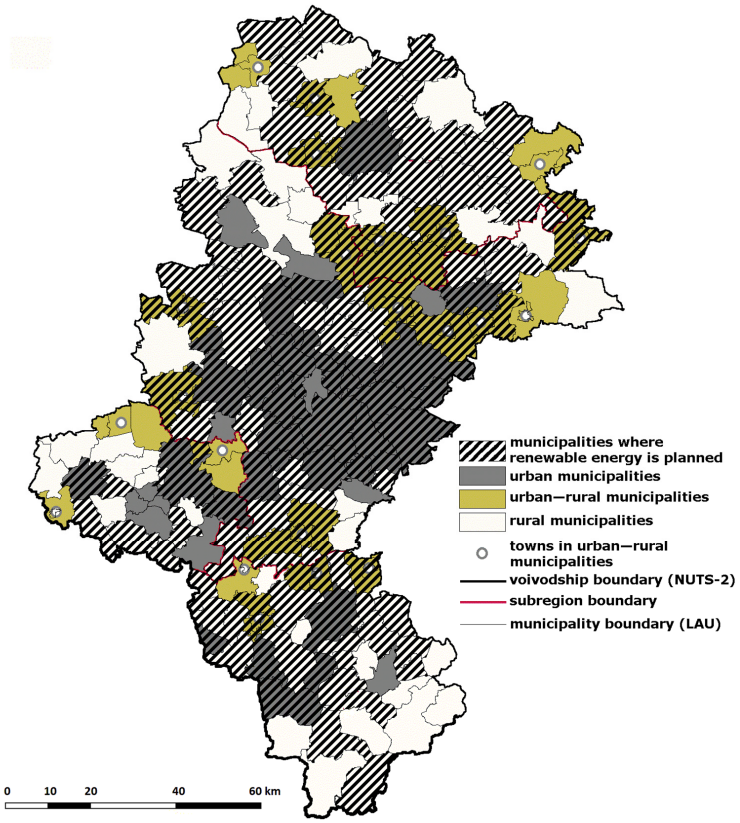
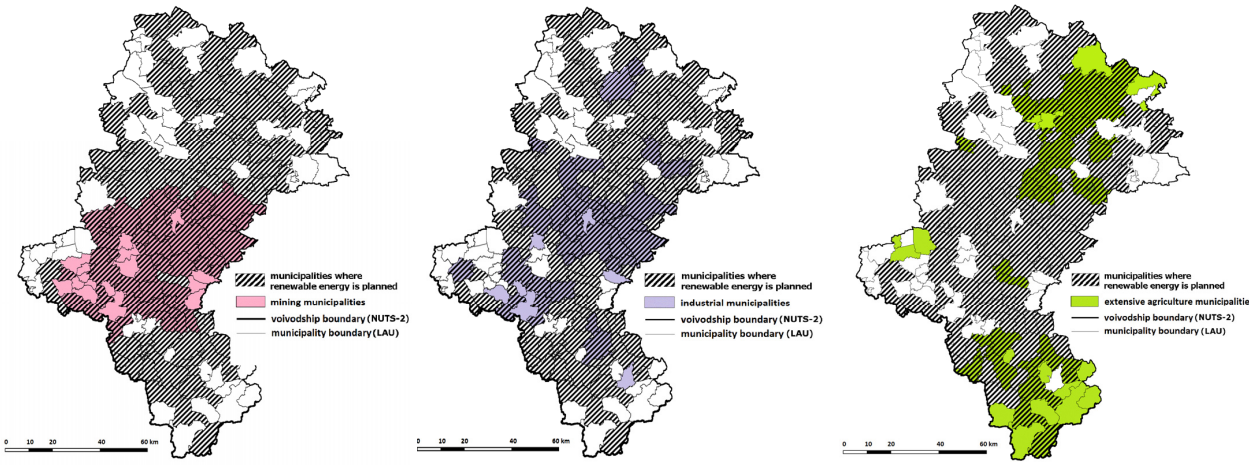


Figure 4. Rural, urban, and urban–rural municipalities of Silesian Voivodship with provisions for renewable energy development. (source: own elaboration based on Central Statistical Office of Republic of Poland data base and Studies of Conditions and Directions of Spatial Development of Silesian Voivodship municipalities).



(**a**) (**b**) (**c**)

Figure 5. Provisions for renewable energy development in Studies of Conditions and Directions of Spatial Development in spatial relation to: (**a**) mining municipalities of the Silesian Voivodship; (**b**) industrial municipalities of the Silesian Voivodship; (**c**) extensive agriculture municipalities of the Silesian Voivodship. (source: own elaboration based on Announcement by The Minister of the Economy of 22 January 2008 on the list of mining municipalities (Journal of Laws item115), Draft. Strategy Of Development of the Silesian Voivodship for the Years 2000–2020, Rural Development Strategy for the Silesian Province by the year 2030 and Studies of Conditions and Directions of Spatial Development of Silesian Voivodship municipalities).

4.3. Types of Land Use Zones for Renewable Energy Development, Wind Energy Development and Solar Energy Development in the Studies of Conditions and Directions of Spatial Development

Analyses of the Studies of Conditions and Directions of Spatial Development shows that in 48 out of 133 of the researched municipalities renewable energy may only be developed in established specific zones/localizations. They are either designed as a separate type of land use only for renewable energy development or they cover one or more zones with other types of land use. Although not all of the municipalities where renewable energy development is planned designated specific localizations for RE infrastructure in their studies, a number of municipalities permitted renewable energy development in zones with other type of land use, as an accompanying function to the main one. These would be for, e.g., agriculture, services, housing, etc. In some municipalities, renewable energy development as an accompanying function is allowed in more than one zone with specific main type of land use.

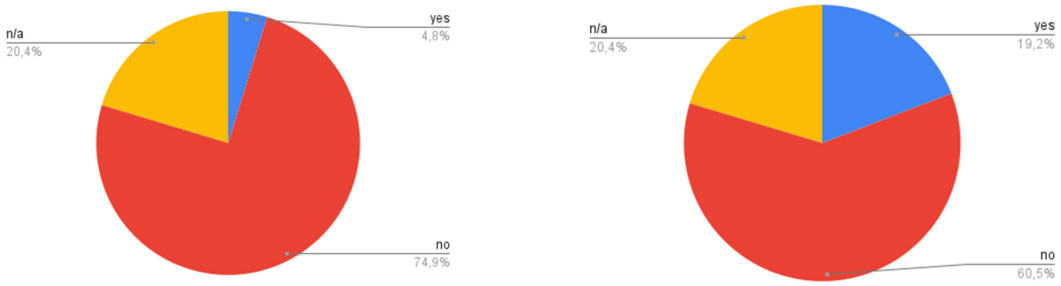
4.3.1. Land Use Zones for Wind Energy Development

Research showed that the most frequent land use type where wind farms are permitted are agriculture zones, agricultural production zones, and meadows (11 municipalities). In total, nine of them were in rural municipalities, the other two were in urban-rural municipalities. Only four municipalities planned wind farms in renewable energy development zones, which were designed as a main form of land use. One of them was an urban municipality, three were urban–rural municipalities. Technical infrastructure zones were chosen for wind energy development in one rural municipality, services zones in one rural municipality. Three municipalities planned wind energy in areas of multifunctional use, such as service and production zones or services, production and trade areas, or areas for the location of service facilities, warehouses, bases, production-zones of various economic activities. One of them was an urban municipality and two were rural municipalities. Only two municipalities planned wind energy in production and mining zones, which already represent industrial landscapes. These were both rural municipalities. Surprisingly, three municipalities planned wind energy development in housing zones in installations both below and above 100 kW. Two were urban–rural municipalities and one was a rural municipality. Green areas are rather protected from wind energy development. Only one rural municipality allowed for its development on these areas. Other types of land use where wind energy is planned are areas excluded from development and with limited development possibilities, for which development parameters and indicators are not specified, in one rural municipality. Figure 6 presents a bar chart with the number of urban municipalities, rural municipalities, and urban–rural municipalities, which allow wind energy development on specific types of land use. Table 2 shows municipalities which allow wind energy development on specific type of land use.

When we assigned these results to other types of municipality classification mentioned in the previous chapter, we learned that four mining municipalities, four industrial municipalities, and nine extensive agriculture municipalities specified in which zone, with specified land use type, wind energy development is planned.

Wind energy development in two mining municipalities is planned in an agriculture land use zone, in one municipality it is planned in a service/production zone, and in another in a mining/production land use zone. In one industrial municipality, wind energy may be developed in renewable energy development zones, in one housing land use zone, and in one services/production land use zone. One industrial municipality planned wind energy development in both an agriculture zone and in a mining activity zone. Most of the extensive agriculture municipalities planned wind energy development in areas where the main land use is agriculture. Five of the nine planned wind power plants were to be constructed in agricultural zones, two in service and production zones, one in housing zones, one in services zone, one in production zone, and one in 'other', such as areas excluded from development and with limited development possibilities. Only one of these municipalities has planned wind energy development in a specific wind energy

development zone. Table 2 shows municipalities which allow wind energy development on specific type of land use with a distinction to urban, rural, urban–rural municipalities, and also mining, industrial, and extensive agriculture.



(**a**) (**b**)

Figure 6. Percentage of the municipalities that in their Studies of Conditions and Directions of Spatial Development have provisions for heritage and historic monuments protection from negative impact of renewable energy facilities (**a**). Percentage of the municipalities that in their Studies of Conditions and Directions of Spatial Development have provisions for valuable landscape protection (Landscape Parks, Protected Landscape Areas and Nature and Landscape Complexes) (**b**). (source: own elaboration based on Studies of Conditions and Development of Silesian Voivodship municipalities).

Table 2. Municipalities which allow wind energy development on specific land use type (own elaboration based on Studies of Conditions and Directions of Spatial Development of Silesian Voivodship municipalities).

Municipality Administrative / Type	Municipality Specific Functional Type	LAU	DEGURBA	Agriculture	Housing	Services	Technical Infrastructure	RE Development	Services/Production	Production/Mining	Green Areas	Others
Urban												
Miasteczko Śląskie	I	1001241451302	2					x				
Piekary Śląskie	M,I	1001241457101	1						x			
Total urban-rural:				0	0	0	0	1	1	0	0	0
Rural												
Wilkowice	E	1001241440210	2	x								
Jasienica	E	1001241440205	3	x	x	x			x	x		
Wielowieś		1001241470508	3	x								
Pawłowice	M,I	1001241511004	3	x						x		
Krzyżanowice		1001241491104	3	x								
Lipie		1001241460603	3	x								
Konopiska	E	1001241460407	3						x			
Gierałtowice		1001241470503	2								x	
Mykanów		1001241460411	3	x								
Poczesna	E	1001241460413	2									x
Przyrów	E	1001241460414	3	x								
Kochanowice		1001241450705	3				x					
Psary	M,E	1001241500106	2	x								
Łękawica	E	1001241441707	2									
Total rural:				9	1	1	1	0	2	2	1	1
Urban-Rural												
Kłobuck		1001241460601	3					x				
Woźniki		1001241450708	3	x	x							
Czechowice-Dziedzice	M,I	1001241440204	2		x							
Żarki	E	1001241460905	3	x								
Łazy	E	1001241501605	3					x				
Szczekociny		1001241501608	3					x				
Total urban-rural:				2	2	0	0	3	0	0	0	0

M—mining; I—industrial; E—extensive agriculture, x—land use on which wind energy development is permitted.

4.3.2. Land Use Zones for Solar Energy Development

Development of photovoltaics, such as wind farms, is mostly planned in agricultural zones (25 municipalities); of these, 7 were urban municipalities, 3 were urban–rural municipalities, and 15 were rural municipalities. Solar energy infrastructure is also often planned in services and production zones (22 municipalities); of these, 8 were urban municipalities, 1 was an urban–rural municipality, and 13 were rural municipalities. More municipalities plan solar energy development in renewable energy zones (16); Five of them were urban municipalities, six were urban–rural municipalities, and five were rural municipalities. Development of solar energy is more often allowed in technical infrastructure zones (15 municipalities). It is planned in six urban, seven rural, and two urban–rural municipalities. It is also planned in service zones (including one with green areas) by 15 municipalities. Seven of them were urban municipalities, three were urban–rural municipalities, and five were rural municipalities. Studies of only 10 municipalities have designated production and mining zones for this type of renewable energy development, which would enable the reuse of these energy production and industrial areas. Five of them were urban and five were rural municipalities. Seven municipalities permitted solar energy development in housing zones (four of them were urban–rural municipalities and three were rural municipalities) and six in green areas and in forests (five of them were urban municipalities and one was a rural municipality). Other zones where solar energy may be developed are areas of mining waste deposition (one urban).

Results of the study showed that 24 mining municipalities, 19 industrial municipalities, and 18 extensive agriculture municipalities specified land use zones where solar energy development is planned.

Solar energy in mining municipalities is mostly planned in services and production zones—12 municipalities; and technical infrastructure zones—8 municipalities. There are seven municipalities which plan solar energy in service zones. Additionally, in 6 out of 24 mining municipalities solar energy may be developed in zones of agricultural land use. In five mining municipalities it is planned in production zones and in four mining municipalities it is planned in renewable energy development zones. Two mining municipalities planned solar energy development in a housing zone. One mining municipality allowed solar energy development in green areas, and in one municipality it is planned in another type of land use, which are areas of deposition (management) of mining waste.

Additionally, in industrial municipalities solar energy is most often planned in service and production zones—9 in total. Eight of the industrial municipalities planned solar energy development in service zones. Six municipalities designated technical infrastructure zones for solar energy facilities. Five municipalities planned it in production and mining zones, and four in green areas, and five municipalities planned it in agricultural zones. Only two municipalities planned solar energy in a renewable energy zone, one municipality in a housing zone, and only one municipality decided to reuse areas of mining waste deposition (management) for solar energy development.

The most frequent land use type for planned solar energy development in extensive agriculture municipalities of the Śląskie Voivodship is, again, service/production zones—9 out of 18 municipalities planned solar energy on this type of land use. Six of these municipalities planned it in agricultural zones; five municipalities designated for that renewable energy development zones; four municipalities planned solar energy in technical infrastructure zones; three municipalities in production/mining zones; and three planned it in services zones. There are two municipalities that planned solar energy in housing zones and one municipality in green areas. Table 3 shows municipalities which allow solar energy development on specific type of land use with a distinction to urban, rural, urban–rural municipalities and also mining, industrial and extensive agriculture.

Table 3. Municipalities which allow solar energy development on specific land use type (own elaboration based on Studies of Conditions and Directions of Spatial Development of Silesian Voivodship municipalities).

Municipality Administrative / Type	Municipality Specific Functional Type	LAU	DEGURBA	Agriculture	Housing	Services	Technical Infrastructure	RE Development	Services/Production	Production/Mining	Green Areas	Others
Urban												
Bytom	M,I	1001241456201	1			x						
Częstochowa	I	1001241466401	1	x		x	x			x	x	
Blachownia	E	1001241460401	2					x				
Jaworzno	M,I	1001241506801	1	x		x						
Ruda Śląska	M,I	1001241487201	1						x	x		
Rybnik	M,I	1001241497301	1				x		x	x		x
Siemianowice Śląskie	M,I	1001241487401	1						x	x		
Sosnowiec	M,I	1001241507501	1				x	x			x	
Tychy	M	1001241517701	1					x				
Miasteczko Śląskie	I	1001241451302	2			x			x			
Wojkowice	M,I	1001241500103	2				x		x			
Sławków		1001241500108	2	x				x	x			
Czeladź	M,I	1001241500102	2					x				
Będzin	M,I	1001241500101	1			x	x		x			
Imielin	M,I	1001241511402	2			x						
Cieszyn		1001241440301	2	x			x				x	
Pyskowice	I	1001241470502	2	x							x	
Łaziska Górne	M,I	1001241510801	2			x			x			
Orzesze	M	1001241510803	2	x								
Myszków	I	1001241460901	2	x							x	
Radzionków	M,I	1001241451303	2							x		
Total urban:				7	0	7	6	5	8	5	5	1
Rural												
Lipie		1001241460603	3	x								
Gierałtowice	M	1001241470503	2	x			x		x	x		
Dębowiec		1001241440306	3				x					
Goleszów	E	1001241440307	3	x					x			
Pilchowice	M	1001241470504	3						x			
Jasienica	E	1001241440205	3		x	x			x	x		
Poczesna	E	1001241460413	2	x								
Przyrów	E	1001241460414	3						x			
Kochanowice		1001241450705	3				x					
Popów		1001241460603	3					x				
Janów	E	1001241460403	3					x	x			
Kruszyna		1001241460408	3						x			
Lelów		1001241511403	3	x								
Pawonków		1001241450707	3	x		x				x		
Mierzęcice	E	1001241500105	3						x			
Bobrowniki	M,E	1001241500104	2				x		x			
Porąbka	E	1001241440208		x		x			x	x		
Kozy	E	1001241440207	2	x						x		
Bestwina	M	1001241440202	2	x								
Wyry	M,E	1001241510805	3		x		x		x			
Poraj	E	1001241460904	2									
Goczałkowice-Zdrój	M	1001241511001	2	x		x						
Kobiór	E	1001241511002	3			x	x		x			
Pawłowice	M,I	1001241511004	3	x								
Krzyżanowice		1001241491104	3					x				
Ożarowice	E	1001241451306	3	x			x				x	
Tworóg		1001241451308	3	x	x							
Zbrosławice		1001241451309	3					x				
Godów	M,I	1001241491505	2						x			
Kroczyce		1001241501604	3	x								

Table 3. *Cont.*

Municipality Administrative / Type	Municipality Specific Functional Type	LAU	DEGURBA	Agriculture	Housing	Services	Technical Infrastructure	RE Development	Services/Production	Production/Mining	Green Areas	Others
Włodowice	E	1001241501609	3	x								
Czernichów	E	1001241441702	3					x				
Total rural:				15	3	5	7	5	13	5	1	0
Urban-Rural												
Kłobuck		1001241460601	3					x				
Woźniki		1001241450708	3	x	x							
Czechowice-Dziedzice	M,I	1001241440204	2		x	x	x		x			
Siewierz	E	1001241500107	3					x				
Wilamowice		1001241440209	2	x	x	x	x					
Skoczów	E	1001241440310	2					x				
Sośnicowice	M	1001241470506	3					x				
Toszek		1001241470507	3	x								
Ogrodzieniec		1001241501606	2		x	x		x				
Szczekociny		1001241501608	3					x				
Total urban-rural:				3	4	3	2	6	1	0	0	0

M—mining; I—industrial; E—extensive agriculture, x—land use on which wind energy development is permitted.

In addition to indicating the localization of renewable energy development in particular zones, the Studies of Conditions and Development mostly do not have specific provisions on rules for locating renewable energy facilities. In most cases there are no specific urban parameters or indicators to describe how these facilities may be added to the main land use function, including how much space of the zone they can use. Only some of the analyzed municipalities, which designated renewable energy zones, have set parameters to those zones, such as color of the facilities, their maximum height, biologically active area, or maximum development area ratio.

4.4. Heritage and Valuable Landscape Protection

The system of spatial planning in Poland requires that Studies of Conditions and Spatial Development have specific provisions for all types of heritage that are in these municipalities. All studies should have a list of heritage objects that are protected by national and local law and designated zones where heritage is protected through defined land use restriction. These restrictions mainly require maintenance of view exposition or high quality of the surroundings of the heritage.

According to the 'List of all objects entered in the register of historic monuments' (as of 19 November 2021) [38] in the Silesian Voivodship there are currently 2702 monuments in 156 municipalities, including buildings, constructions, and urban and rural arrangements that are without archeological monuments or monuments which are still in the legal parameters of inclusion. Objects on this list consist of historical monuments, which are protected on national level. In addition to this national list, each municipality has their own list of monuments called the Communal Historic Monuments Register, all of which are protected by the local laws of this municipality.

In 127 out of the 133 analyzed municipalities, there is at least one historic monument (29 of 156 of the municipalities which have historic monuments did not provide access to the Studies of Conditions and Directions of Spatial Development). Research showed that renewable energy development is allowed in 110 of them. More specifically, wind

energy development is planned in 31 and solar energy in 77 of them. Although transition to renewable energy development is planned in a large number of the analyzed Studies of Conditions and Spatial Development, only 8 out of 133 have any provisions for protecting heritage from the negative impacts of renewable energy development, which accounts for only 4.8% of all analyzed studies (Table 4). Figure 6a shows the percentage of the municipalities that have provisions for heritage and historic monuments protection from negative impact of renewable energy facilities in their Studies of Conditions and Directions of Spatial Development.

Table 4. Municipalities of the Silesian Voivodship which have provisions on the protection of heritage and valuable landscapes in connection with the development of renewable energy (own elaboration based on Studies of Conditions and Directions of Spatial Development of Silesian Voivodship municipalities).

Municipality	LAU	DEGURBA	Specific Provisions Due to Protection of:				Distance From Protected Areas		Additional Visual Studies	
			Cultural Heritage		Valuable Landscapes					
			w	s	w	s	w	s	w	s
Mstów	1001241460410	3	x		x					
Miasteczko Śląskie	1001241451302	2	x	x	x	x				
Porąbka	1001241440208	2	x	x		x				
Buczkowice	1001241440203	2	x	x		x				
Gierałtowice	1001241470503	2	x	x						
Pilchowice	1001241470504	3	x	x		x				
Wyry	1001241510805	2	x	x						
Sosnowiec	1001241507501	1	x	x						
Lipie	1001241460603	3			x	x		x		
Wręczyca Wielka	1001241460609	3			x	x				
Kochanowice	1001241450705	3			x	x		x		
Wilkowice	1001241440210	2			x				x	
Szczyrk	1001241440201	2			x					
Czechowice-Dziedzice	1001241440204	2			x	x				
Blachownia	1001241460401	2				x				
Bestwina	1001241440202	2				x				
Czernichów	1001241441702	3				x		x		
Janów	1001241460403	3				x		x		
Przyrów	1001241460414	3			x		x	x		
Łazy	1001241501605	3			x				x	
Total			8	7	10	12	1	5	2	0

w—wind farms; s—solar farms, , x—land use on which wind energy development is permitted.

In all of the eight municipalities mentioned above, renewable energy development is planned. This means that more than 92% of analyzed municipalities that have historic monuments, planned renewable energy development without any provisions to protect heritage and historic monuments from negative spatial and visual impact on those monuments.

In total, 25 of the historic monuments on the 'List of all objects entered in the register of historic monuments' are monuments related to the mining-heritage of the region. They may be found in eight municipalities in the central part of the Silesian Voivodship. Table A2 in Appendix B presents the list of these historic monuments related to mining-culture in the Silesian Voivodship.

There are no historic monuments of national importance related to mining in any of the eight municipalities with provisions for heritage and historic monument protection. This means that, due to the possibility of renewable energy development, this type of monument may be affected by the negative impacts of renewable energy facilities, but on the other hand the lack of legal regulations related to heritage and monument protection might allow the introduction of alternative types of energy production in areas where the landscape has already been heavily transformed by facilities related to coal mining. Figure 7 shows municipalities with monuments related to the mining-heritage of the voivodship in relation to municipalities where renewable energy is planned in Studies of Conditions and Directions of Spatial Development and municipalities whose studies have provisions for valuable landscape protection from the negative impacts of renewable energy development.

In the Act of Nature Protection from 16 April 2004 there are three legal forms of nature protection that may be established to protect valuable landscapes: landscape parks,

protected landscape areas, and natural and landscape complexes [39]. According to the legal definitions coming from this Act, landscape parks are established to protect "the areas with natural, historical, cultural and landscape values in order to preserve and popularize these values in the conditions of sustainable development", protected landscape areas "include areas protected due to the distinctive landscape with diverse ecosystems, valuable due to the ability to meet related needs with tourism and leisure or with the function of ecological corridors", and nature and landscape complexes are "fragments of the landscape that are natural and cultural heritage deserving protection due to their scenic or aesthetic values".

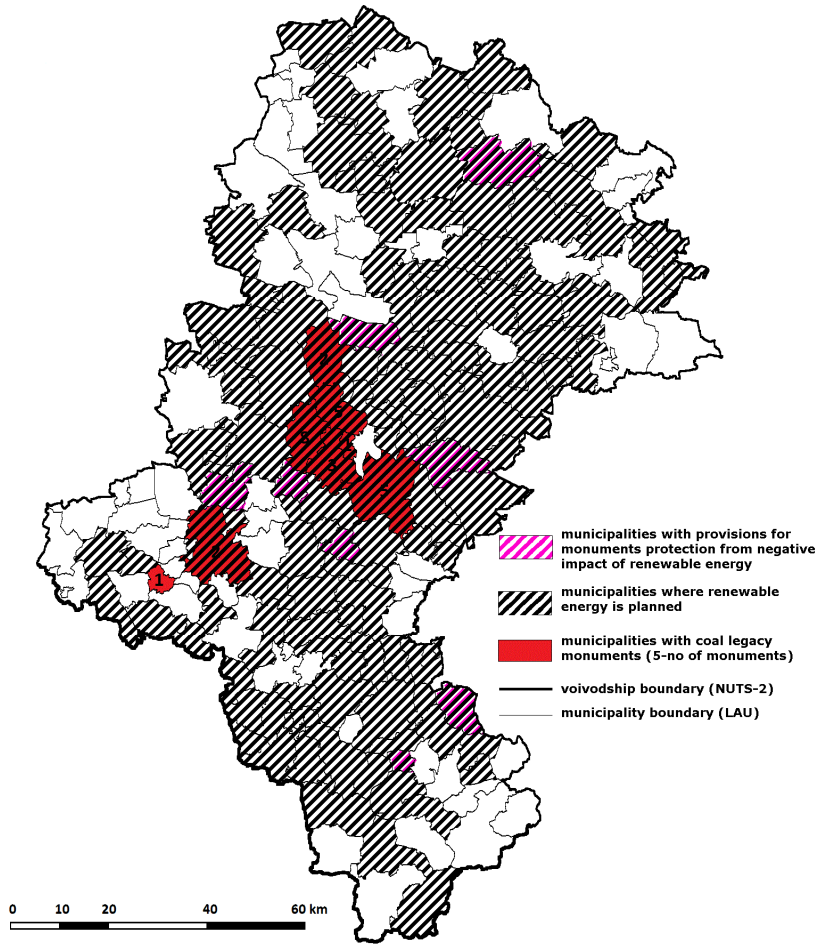


Figure 7. Municipalities with monuments related to mining-heritage of the Voivodship in relation to municipalities where renewable energy is planned in Studies of Conditions and Directions of Spatial Development and municipalities whose studies have provisions for valuable landscape protection from negative impact of renewable energy development. (source: own elaboration based on the list of all objects entered in the register of historic monuments (as of 19 November 2021) and Studies of Conditions and Directions of Spatial Development of Silesian Voivodship municipalities).

In the Silesian Voivodship there are 8 landscape parks in 67 municipalities. Their total area constitutes around 18.5% of the entire area of the Silesian Voivodship [40]. There are also 15 protected landscape areas in 18 municipalities and 26 nature and landscape complexes in 18 municipalities [41]. Table A3 in Appendix C contains the list of landscape parks in municipalities of the Silesian Voivodship, Table A4 contains the list of protected landscape areas and Table A5 contains the list of nature and landscape complexes.

All three legal forms of nature protection, established to protect valuable landscapes, are found in 90 municipalities. In total, 74 of these municipalities have available Studies of Conditions and Spatial Development.

According to provisions from the analyzed studies, renewable energy is planned in 63 of these municipalities. Despite the fact that 32 out of 133 analyzed studies have provisions for valuable nature areas and landscape protection from negative renewable energy impacts, only 18 from the aforementioned 63 municipalities have any provisions regarding protection from the negative impacts of renewable energy facilities on valuable landscapes in their studies. Figure 6b shows the percentage of the municipalities that include provisions for valuable landscape protection (Landscape parks, areas of protected landscape, and nature and landscape complexes) in their Studies of Conditions and Directions of Spatial Development.

This means that more than 70% municipalities with any legal form of valuable landscape protection including landscape parks, protected landscape areas or nature and landscape complexes, where renewable energy is planned, have no provisions in their studies that limit the possible negative impacts of the renewable energy facilities. Figure 8 presents municipalities with landscape parks, protected landscape areas, and natural and landscape complexes in relation to municipalities where renewable energy is planned in Studies of Conditions and Directions of Spatial Development, and municipalities whose studies have provisions for valuable landscape protection from the negative impacts of renewable energy development.

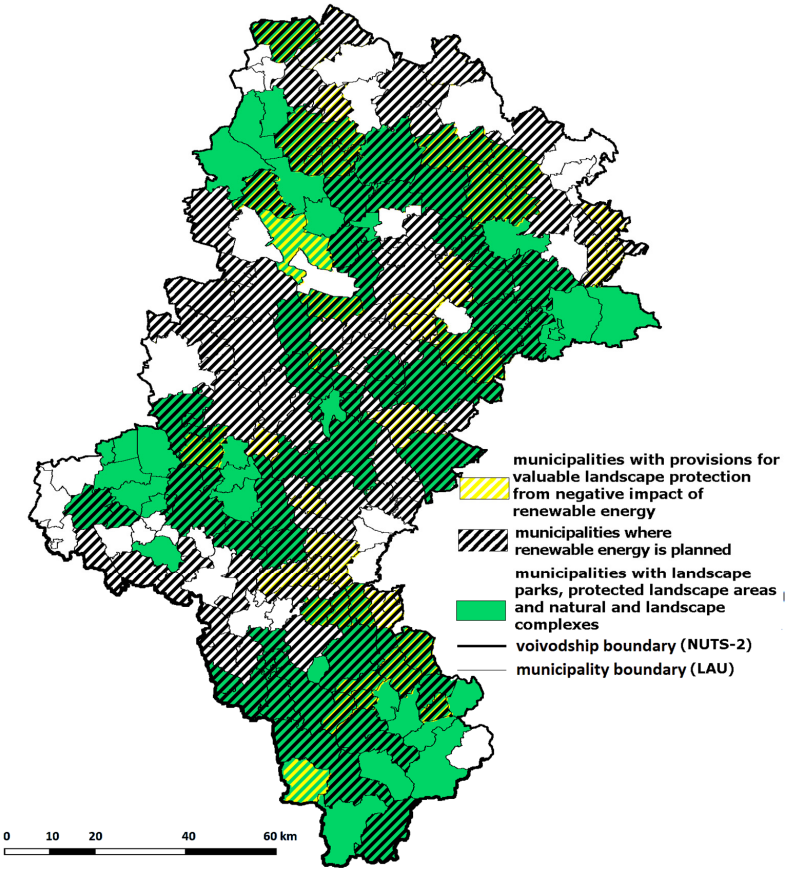


Figure 8. Municipalities with landscape parks, protected landscape areas, and natural and landscape complexes in relation to municipalities where renewable energy is planned in Studies of Conditions and Directions of Spatial Development and municipalities whose studies have provisions for valuable landscape protection from the negative impacts of renewable energy development. (source: own elaboration based on: General Directorate for Environmental Protection. Central Register of Nature Protection Forms and Studies of Conditions and Directions of Spatial Development of the Silesian Voivodship municipalities).

Wind energy development is planned in 20 municipalities with any legal form of valuable landscape protection. Of those municipalities, 10 had some sort of provisions for protection of valuable landscapes (Table 4).

In most cases the main aim of these provisions is to forbid development of wind or wind and solar energy facilities in areas of nature protection. In two municipalities, wind energy may be developed, but the locations for the power plants require local spatial development plans to study the visual and landscape impact.

Solar energy development is planned in 43 municipalities with at least one legal form of valuable landscape protection. However, only 12 of them had any provision for protection of valuable landscapes. Due to these provisions, in most cases, it is forbidden to develop energy facilities inside established forms of nature protection. According to the provisions of the studies for five municipalities, development of renewable energy should only be permitted a significant specific distance from nature protection forms, including those established for valuable landscape protection.

5. Discussion

The subject of renewable energy development in Poland is a very broad one. In this article, we intentionally do not discuss in detail aspects related to national energy policy, social consequences of energy transition, as well as technical and economic conditions which significantly influence the pace of energy transition to renewable sources. With this publication we would like to draw attention to the fact that the development of renewable energy must also be more thought out in terms of spatial policy and the distribution of facilities in space in order to make this development more sustainable. It should be remembered that landscape resources are limited and the need for contact with the untouched landscape is becoming more and more difficult to satisfy [13].

RES already, even with the small number of existing installations, causes social conflicts at a local and regional level; however, due to the climate and the environmental protection resulting, the developments received from this technology should unite people [42]. Planning RE as far as possible in places that have already been transformed is a goal that should guide us in order to protect the landscape and its visual representation. Moving facilities to new locations means that other infrastructure also has to be constructed, such as roads, power lines, etc., so the impact on the landscape increases more in that situation and the economic cost of that is also higher. It also does not force people to migrate to new locations for jobs in the energy industry.

This study analyzed the spatial policies of municipalities in the Silesian Voivodship in order to determine the scope of wind and solar energy spatial development and to assess possibilities of predicting the effects they will have on the landscape.

The visual intrusion associated with the large-scale use of wind and solar energy has been linked by many researchers to two important aspects that can affect landscape quality. The first is the physical characteristics of wind and solar farms, and the second is where they are located. The physical characteristics include: size [1,43,44], area [1,7,8], color [43,45,46].

The impact associated with the siting of wind and solar farms is mostly related to: distance [11,44,47], land cover [11,47,48], and existing landscape character [1,47,49].

Most of the provisions in the analyzed spatial policies regarding renewable energy development are limited to a short description about whether renewable energy development is allowed in a particular municipality or not. Some of the municipalities provide more specific descriptions regarding renewable energy development, however in most cases they do not contain such essential provisions as:

- Specific types of renewable energy facilities that are allowed in particular municipality;
- The area that they can occupy;
- Height of allowed facilities;
- Areas that should be protected from the negative impact of renewable energy development.

In only three of the analyzed municipalities—Toszek (LAU 1001241470507), Pyskowice (LAU 1001241470502), and Orzesze (LAU 1001241510803), the studies have provisions to restore the land to agricultural use after the decommissioning of planned photovoltaic facilities. The aspects of repowering of renewable energy facilities were not taken into account in any of the municipalities. However, it should be an important issue in RE facilities development [48,50].

To a large extent, the poor provisions of analyzed spatial policies may be due to the lack of formal requirements on the content of local spatial policies related to the development of RES in Poland. Another problem is the lack of a coherent planning system for renewable energy at the various administration levels. This is reflected in the differences in the extent of renewable energy development according to the provisos of the Regional Spatial Development Plan (Figure 2a) and the provisions of Studies of Conditions and Directions of Spatial Development prepared by local authorities (Figure 5). Under regional plan renewable energy should be developed in rural areas, while analysis of municipal documents showed that urban and urban–rural municipalities are also willing to develop RES in their territories. The UK National Planning Policy Framework encourages the development of solar farms on previously developed and non-agricultural land, provided that it is not of high natural value [51]. In Germany, agricultural land and industrial land are usually designated as concentration zones of RES development [52]. In the US, building on previously disturbed land and combining renewable power with other land uses, such as agriculture, is one of the means to minimize land use conflicts [12].

In view of the above, the impact of RES development on the landscape cannot be unambiguously determined.

However, considering the importance of pushing forward the energy transition, due to the goals of the European Green Deal, the high pressure in the European Union to change the continent into, first, carbon neutral by 2050, and then to switch from coal-based energy production, the lack of proper and detailed spatial planning of RE facilities regarding characteristics of each region should be taken into account more seriously than it is for now [2,26].

Since World War II, in Poland it has been assumed that the source of energy is a guarantee of energy independence. Today, the technology of energy production from coal is outdated, but many factors slow down the transition. In Poland, sentiment towards mining-traditions seem to be strong. A lack of proper legal landscape conservation tools for protection against possible negative impacts has caused strong social resistance. The NIMBY effect has blocked many investments. At the same time, transition is difficult from the economic and technological perspective because the country is dependent on coal as a main energy source. The ambitious goals of the Green New Deal are rather difficult to be achieved in Poland [26,42]. Even though Energy Policy of Poland by 2040 [53] has very optimistic arrangements for development, the Report of the Supreme Audit Office NIK of 2020, shows that the current strategy for transition does not work and needs improvement [54]. However, if the trend would change, in line with Energy Policy of Poland by 2040 (share of RES energy in the electric power industry will reach about 40% net due to legal support and technological and economic level of development and the visible growth will start after 2025).

This means that there is a potential risk that resources, such as the landscape and its visual representation, would become soon largely affected. In a situation where the spatial planning of renewable energy facilities is marginalized, the quality of the new type of energy landscapes and the scale of their impact will be big issues for sustainable development in terms of nature conservation and valuable landscape protection [9]. Having that perspective, there is not much time to improve provisions in Studies of Conditions and Directions of Spatial Development and other documents on local and regional level towards renewable energy development for landscape character protection and quality planning.

Using the example of the Silesian Voivodship, it is clear that the energy transition in spatial terms is not taking place only directly in the same locations where the landscape was

previously altered by coal-mining and the related industrialization. At the same time, the rather general Strategy and Spatial Plan of the Silesian Voivodship translate into equally not detailed provisions on the willingness to develop RES in the vast majority of municipalities in the province. The fact that provisions in the studies are so general may be due to the willingness of local governments to encourage investors to develop renewable energy within their municipalities. However, the frequent lack of detailed provisions on the spatial distribution of RE facilities and planning RE in areas other than mining and industrial areas, or provisions for protection of cultural landscapes with historical monuments and valuable natural landscapes, may in the future have serious consequences for the quality of life of residents of these areas, by introducing spatial chaos with installations which can become the new landscape dominants and drastically alter the perception of their surroundings. In fact, there are already proven examples of places where property values and the quality of life of residents have decreased by the appearance of RES in the vicinity [47]. Thus, examples of good practices of thoughtful spatial planning and design of solar energy facilities directly in the abandoned mining sites (with sufficient solar exposure conditions), coming from other coal-regions, such as in Saarland in Germany, might be both cost and spatial effective solutions in municipalities mentioned in the introduction, with spatial problems related to economic transformation of the Silesian Voivodship [55].

The current state of RES planning in municipalities may be due to a lack of legal tools, specific guidelines, and, from the beginning, mainly the understanding of local authorities in the municipalities of the scale of spatial changes that need to take place in order to transition and replace mines and coal power plants with large-scale wind farms or photovoltaic farms [18,56,57]. RES planned in new areas, e.g., agricultural or residential areas, change the landscape character and perception and affect a new, larger group of landscape users than before. Currently the development of RES in Poland is slowed down by the unstable legal situation related to RES, changing ways of accounting and support systems for this type of investments, as well as the so-called Distance Act of 2016 with 10H rule (In Poland, the current regulations limit the development of wind energy to locations far away from residential buildings) [58]. However, if the position of the government changes, investors will be able to change most of the land in the Silesian Voivodship into industrial energy landscapes on the basis of the current planning documents.

It is, therefore, important to monitor and analyze planning documents for the development of RES on a municipality scale, as they have the final impact on landscape changes on a regional scale. It is important to remember that while planning the transition to renewable energy sources that they often constitute new spatial dominants and influence the environment not only on a municipality scale. In the case of RES planning, the importance of landscape audits according to the European Landscape Convention 2000 [59] is clearly visible, which will allow the identification of priority landscapes in the whole voivodship and to take into account their protection in the planning documents. (Currently, a landscape audit is being prepared for the Silesian Voivodship to identify such landscapes). It is also necessary to encourage municipalities to plan RES on their territory in a more precise way, specifying the parameters of particular installations which can be constructed in a given location. They should also pay attention to whether the planned installations are likely to fit harmoniously into the existing landscape, by specifying the minimum and maximum number of objects, their maximum height, colors, or spatial distribution. Good provisions and appropriate planning may limit the negative impact of RES on the landscape and, thus, improve its perception by users [18].

6. Conclusions

Concluding the obtained results, it has to be said that methods used in this research has enabled us to determine that local regulations do not take into consideration the type of municipality, as well as the land use and landscape value in the development of renewable energy. Renewable energy facilities are often planned in non-mining and non-industrial municipalities. This will involve the creation of new industrial cultural landscapes—energy

landscapes related to the development of wind farms and photovoltaics and modification of other types of landscape, such as Highly Valuable Natural Landscapes.

The analysis of the municipal studies indicates that the municipalities have a preference for photovoltaic energy development over wind energy development. Wind energy development is allowed in 34 (20.4%) municipalities, while photovoltaics are allowed in 80 (47.9%) municipalities. Wind farms above 100 kW are banned in the vast majority of municipalities, even if RES development is allowed in them. To a large extent, this is related to the introduction of the Distance Act of 2016, which requires the designation of protection zones around wind farms above 100 kW, in which buildings may not be located.

Renewable energy development will have a significant impact on the perception of rural landscapes of Silesian Voivodship, because the development of wind farms is mostly planned on agricultural land in rural municipalities due to the best capacity of the wind in these areas. This will be particularly felt in the southern sub-region of the voivodship, which is mountainous in character.

Less than half of the municipalities whose studies were analyzed designate renewable energy zones. In most municipalities renewable power will be co-located with other land uses. According to analyzed studies, wind and solar installations will most often share land with agriculture, services, and production.

Results of the research confirmed our hypothesis, that provisions for RE development of most of the analyzed Studies of Conditions and Development are too general to maintain the quality of the landscape. Renewable energy development is planned in the large number of analyzed municipalities. However, aspects such as localization, permitted type of the facility, and their basic parameters, such as number, height, spacing, and color are often not provided in the Studies of Condition and Spatial Development. Facilities are planned not only in mining and industrial municipalities, but also in extensive agriculture municipalities. There are also not many examples of reusing post-mining areas by planning RE infrastructure there. However, RE development, if this information is provided, is not only planned in renewable energy zones or in service and production land use zones. It is also allowed in a large number of agriculture land use zones, housing zones, green areas, and other types of land use, which will extend the area occupied by energy landscapes. Without the proper regulations further transition towards renewable energy can cause landscape degradation by its further industrialization and can be perceived as unsustainable. Impact of the renewable energy facilities often extends beyond the municipality boundaries and may affect also landscapes of neighboring municipalities. Our research showed also that without more specific regulation on the regional level, renewable energy landscapes may appear in most of the municipalities. This is something that should be avoided on regional level, by analyzing sensitivity and capacity of voivodship landscapes and eliminating important ones that should be protected from renewable energy development [19]. Identification of priority landscapes based on landscape audit of the Silesian Voivodship and more specific provisions for energy production areas may help to improve this situation in the future and fulfill the most important goal of spatial planning by reducing possible social, economic and environmental conflicts.

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Appendix A

Table A1. General characteristics of Silesian Voivodship municipalities (source: own elaboration based on: Eurostat database https://ec.europa.eu/eurostat/web/nuts/local-administrative-units (accessed on 5 January 2022)).

Name of Municipality	NUTS 3	LAU	DEGURBA	Population (2021)	Area (ha) (2021)
Bestwina	PL225	1001241440202	2	11,950	3792
Będzin	PL22B	1001241500101	1	56,008	3737
Bielsko-Biała	PL225	1001241446101	1	169,756	12,451
Bieruń	PL22C	1001241511401	2	19,375	4049
Blachownia	PL224	1001241460401	2	12,831	6661
Bobrowniki	PL22B	1001241500104	2	12,122	5148
Bojszowy	PL22C	1001241511404	3	8045	3469
Boronów	PL228	1001241450702	3	3449	5728
Brenna	PL225	1001241440304	3	11,373	9561
Buczkowice	PL225	1001241440203	2	11,226	1946
Bytom	PL228	1001241456201	1	163,255	6944
Chełm Śląski	PL22C	1001241511405	2	6403	2333
Chorzów	PL22A	1001241486301	1	106,846	3324
Chybie	PL225	1001241440305	2	9832	3175
Ciasna	PL228	1001241450703	3	7388	13,395
Cieszyn	PL225	1001241440301	2	33,981	2861
Czechowice-Dziedzice	PL225	1001241440204	2	45,490	6648
Czeladź	PL22B	1001241500102	2	31,039	1638
Czernichów	PL225	1001241441702	3	6663	5640
Czerwionka-Leszczyny	PL227	1001241491201	2	41,909	11,464
Częstochowa	PL224	1001241466401	1	217,530	15,971
Dąbrowa Górnicza	PL22B	1001241506501	1	118,285	18,873
Dąbrowa Zielona	PL224	1001241460402	3	3848	10,021
Dębowiec	PL225	1001241440306	3	5845	4264
Gaszowice	PL227	1001241491202	2	9856	1985
Gierałtowice	PL229	1001241470503	2	12,252	3806
Gilowice	PL225	1001241441703	2	6327	2795
Gliwice	PL229	1001241476601	1	177,049	13,388
Goczałkowice-Zdrój	PL22C	1001241511001	2	6735	4739
Godów	PL227	1001241491505	2	13,845	3805
Goleszów	PL225	1001241440307	3	13,142	6587
Gorzyce	PL227	1001241491506	2	21,370	6458
Hażlach	PL225	1001241440308	3	10,919	4878
Herby	PL228	1001241450704	3	6769	8591
Imielin	PL22C	1001241511402	2	9269	2799
Irządze	PL22B	1001241501603	3	2579	7100
Istebna	PL225	1001241440309	3	12,184	8432
Janów	PL224	1001241460403	3	5958	14,675
Jasienica	PL225	1001241440205	3	24,681	9167
Jastrzębie-Zdrój	PL227	1001241496701	1	88,038	8533
Jaworze	PL225	1001241440206	2	7443	2113
Jaworzno	PL22B	1001241506801	1	90,368	15,259
Jejkowice	PL227	1001241491203	2	4185	759
Jeleśnia	PL225	1001241441704	3	13,210	17,062
Kalety	PL228	1001241451301	2	8548	7629
Kamienica Polska	PL224	1001241460404	3	5514	4645
Katowice	PL22A	1001241486901	1	290,553	16,464

Table A1. *Cont.*

Name of Municipality	NUTS 3	LAU	DEGURBA	Population (2021)	Area (ha) (2021)
Kłobuck	PL224	1001241460601	3	20,213	13,001
Kłomnice	PL224	1001241460405	3	13,422	14,773
Knurów	PL229	1001241470501	2	37,801	3395
Kobiór	PL22C	1001241511002	3	4971	4819
Kochanowice	PL228	1001241450705	3	6959	8002
Koniecpol	PL224	1001241460406	2	9283	14,662
Konopiska	PL224	1001241460407	3	10,728	7851
Kornowac	PL227	1001241491102	3	5165	2620
Koszarawa	PL225	1001241441705	3	2346	3156
Koszęcin	PL228	1001241450706	3	11,810	12,918
Koziegłowy	PL224	1001241460902	3	14,348	15,964
Kozy	PL225	1001241440207	2	13,091	2674
Kroczyce	PL22B	1001241501604	3	6239	11,005
Krupski Młyn	PL228	1001241451305	3	3177	3908
Kruszyna	PL224	1001241460408	3	4802	9355
Krzanowice	PL227	1001241491103	3	5676	4720
Krzepice	PL224	1001241460602	3	9010	7894
Krzyżanowice	PL227	1001241491104	3	11,185	6970
Kuźnia Raciborska	PL227	1001241491105	2	11,641	12,662
Lelów	PL224	1001241460409	3	4794	12,369
Lędziny	PL22C	1001241511403	2	16,731	3165
Lipie	PL224	1001241460603	3	6204	9905
Lipowa	PL225	1001241441706	2	10,872	5872
Lubliniec	PL228	1001241450701	2	23,551	8936
Lubomia	PL227	1001241491507	2	7903	4178
Lyski	PL227	1001241491204	3	9676	5739
Łaziska Górne	PL22C	1001241510801	2	22,130	2011
Łazy	PL22B	1001241501605	3	15,851	13,293
Łękawica	PL225	1001241441707	2	4560	4277
Łodygowice	PL225	1001241441708	2	14,637	3586
Marklowice	PL227	1001241491508	2	5417	1369
Miasteczko Śląskie	PL228	1001241451302	2	7418	6783
Miedźna	PL22C	1001241511003	2	16,660	5009
Miedźno	PL224	1001241460604	3	7518	11,277
Mierzęcice	PL22B	1001241500105	3	7623	4943
Mikołów	PL22C	1001241510802	2	41,003	7921
Milówka	PL225	1001241441709	3	10,040	9888
Mstów	PL224	1001241460410	3	10,846	11,957
Mszana	PL227	1001241491509	2	7684	3122
Mykanów	PL224	1001241460411	3	15,164	14,156
Mysłowice	PL22A	1001241487001	1	74,559	6562
Myszków	PL224	1001241460901	2	31,261	7359
Nędza	PL227	1001241491106	3	7446	5722
Niegowa	PL224	1001241460903	3	5604	8796
Ogrodzieniec	PL22B	1001241501606	2	9018	8473
Olsztyn	PL224	1001241460412	3	7835	10,910
Opatów	PL224	1001241460605	3	6805	7348
Ornontowice	PL22C	1001241510804	2	6179	1545
Orzesze	PL22C	1001241510803	2	21,290	8371
Ożarowice	PL228	1001241451306	3	5806	4588
Panki	PL224	1001241460606	3	5035	5494
Pawłowice	PL22C	1001241511004	3	18,156	7568
Pawonków	PL228	1001241450707	3	6615	11,893
Piekary Śląskie	PL228	1001241457101	1	54,702	3998
Pietrowice Wielkie	PL227	1001241491107	3	6888	6793
Pilchowice	PL229	1001241470504	3	12,138	6983
Pilica	PL22B	1001241501607	3	8534	14,276
Poczesna	PL224	1001241460413	2	12,641	5998

Table A1. *Cont.*

Name of Municipality	NUTS 3	LAU	DEGURBA	Population (2021)	Area (ha) (2021)
Popów	PL224	1001241460607	3	5835	10,229
Poraj	PL224	1001241460904	2	10,822	5706
Porąbka	PL225	1001241440208	2	15,581	6443
Poręba	PL22B	1001241501601	2	8461	3999
Przyrów	PL224	1001241460414	3	3737	8040
Przystajń	PL224	1001241460608	3	5849	8883
Psary	PL22B	1001241500106	2	12,268	4616
Pszczyna	PL22C	1001241511005	2	52,823	17,473
Pszów	PL227	1001241491501	2	13,734	2044
Pyskowice	PL229	1001241470502	2	18,455	3089
Racibórz	PL227	1001241491101	2	54,259	7501
Radlin	PL227	1001241491502	2	17,665	1253
Radziechowy-Wieprz	PL225	1001241441710	2	13,068	6486
Radzionków	PL228	1001241451303	2	16,903	1320
Rajcza	PL225	1001241441711	3	8709	13,142
Rędziny	PL224	1001241460415	2	9850	4123
Ruda Śląska	PL22A	1001241487201	1	136,423	7773
Rudnik	PL227	1001241491108	3	5150	7388
Rudziniec	PL229	1001241470505	3	10,682	15,914
Rybnik	PL227	1001241497301	1	137,128	14,836
Rydułtowy	PL227	1001241491503	2	21,385	1495
Siemianowice Śląskie	PL22A	1001241487401	1	66,270	2550
Siewierz	PL22B	1001241500107	3	12,387	11,385
Skoczów	PL225	1001241440310	2	26,788	6355
Sławków	PL22B	1001241500108	2	6935	3667
Sosnowiec	PL22B	1001241507501	1	197,586	9106
Sośnicowice	PL229	1001241470506	3	8906	11,650
Starcza	PL224	1001241460416	3	2853	2009
Strumień	PL225	1001241440311	3	13,256	5854
Suszec	PL22C	1001241511006	2	12,469	7508
Szczekociny	PL22B	1001241501608	3	7538	13,393
Szczyrk	PL225	1001241440201	2	5710	3907
Ślemień	PL225	1001241441712	3	3534	4502
Świerklaniec	PL228	1001241451307	2	12,505	4463
Świerklany	PL227	1001241491205	2	12,540	2417
Świętochłowice	PL22A	1001241487601	1	49,108	1331
Świnna	PL225	1001241441713	2	8054	3918
Tarnowskie Góry	PL228	1001241451304	2	61,756	8388
Toszek	PL229	1001241470507	3	9361	9982
Tworóg	PL228	1001241451308	3	8282	12,504
Tychy	PL22C	1001241517701	1	126,871	8181
Ujsoły	PL225	1001241441714	3	4406	10,981
Ustroń	PL225	1001241440302	2	15,989	5903
Węgierska Górka	PL225	1001241441715	2	15,040	7647
Wielowieś	PL229	1001241470508	3	5821	11,618
Wilamowice	PL225	1001241440209	2	17,794	5734
Wilkowice	PL225	1001241440210	2	13,382	3440
Wisła	PL225	1001241440303	2	11,007	11,017
Włodowice	PL22B	1001241501609	3	5203	7679
Wodzisław Śląski	PL227	1001241491504	2	47,576	4951
Wojkowice	PL22B	1001241500103	2	8877	1279
Woźniki	PL228	1001241450708	3	9568	12,762
Wręczyca Wielka	PL224	1001241460609	3	17,861	14,828
Wyry	PL22C	1001241510805	2	8600	3462

Table A1. *Cont.*

Name of Municipality	NUTS 3	LAU	DEGURBA	Population (2021)	Area (ha) (2021)
Zabrze	PL229	1001241477801	1	170,924	8040
Zawiercie	PL22B	1001241501602	2	48,703	8525
Zbrosławice	PL228	1001241451309	3	16,385	14,836
Zebrzydowice	PL225	1001241440312	2	13,220	4142
Żarki	PL224	1001241460905	3	8451	10,100
Żarnowiec	PL22B	1001241501610	3	4546	12,480
Żory	PL227	1001241497901	1	62,844	6464
Żywiec	PL225	1001241441701	2	30,733	5054
Total				**4,492,330**	**1,233,309**

Appendix B

Table A2. Historic monuments related to mining-culture in Silesian Voivodship (source: own elaboration based on the list of all objects entered in the register of historic monuments (as of 19 November 2021)).

Municipality (Type)	NUTS 3	LAU	DEGURBA	Description of Historic Monument
Bytom (urban)	PL228	1001241456201	1	The hoisting tower of the Krystyna Shaft of the former Szombierki coal mine together with the immediate surroundings and the remains of equipment
Bytom (urban)	PL228	1001241456201	1	Cemetery of the Roman Catholic Parish St. Jack with mass grave of miners who died in the catastrophe in the "Heinitz" mine
Bytom (urban)	PL228	1001241456201	1	Building complex of the main area of the former "Rozbark" mine
Bytom (urban)	PL228	1001241456201	1	Building of the shaft of the "Western" ventilation shaft with the steel shaft structure of the Preusen mine (later KWK Miechowice)
Bytom (urban)	PL228	1001241456201	1	Building of the hoisting machine of the Preusen mine (later KWK Miechowice)
Katowice (urban)	PL22A	1001241486901	1	Former buildings of the "Alfred" shaft of the former "Wełowiec" mine
Katowice (urban)	PL22A	1001241486901	1	Former villa of the director of the Giesche mine
Katowice (urban)	PL22A	1001241486901	1	Building of the Nowa Łaźnia Łaźnia in the area of the Wujek coal mine
Katowice (urban)	PL22A	1001241486901	1	Building of the former clothing and fuel warehouse of the OHEIM mine, currently the Museum, the Wujek Mine Memorial Room
Katowice (urban)	PL22A	1001241486901	1	Avenue consisting of 150 trees, birches, located along both sides of the road leading from the Murcki railway station to the Murcki mine
Pszów (urban)	PL227	1001241491501	2	Buildings included in the development of the "Anna" coal mine
Ruda Śląska (urban)	PL22A	1001241487201	1	Steam hoisting machine (two-cylinder, so-called twin, horizontal, type BB-4.5, power 428KM, year from 1893) on the "Jurand II" shaft with the building in which it is located in the "Karol" coal mine
Ruda Śląska (urban)	PL22A	1001241487201	1	Top-shaft building of the "Andrzej" shaft of the former mine "God's Blessing" (now "Peace")
Ruda Śląska (urban)	PL22A	1001241487201	1	Complex of buildings of the former "Franciszek" shaft of the Wawel mine
Rybnik (urban)	PL227	1001241497301	1	Workers' housing estate at the "Rymer" coal mine with an adjacent park

Table A2. *Cont.*

Municipality (Type)	NUTS 3	LAU	DEGURBA	Description of Historic Monument
Rybnik (urban)	PL227	1001241497301	1	Development complex and the immediate surroundings of the former Ignacy-Hoym mine (now Kompania Węglowa SA KWK Rydułtowy-Anna Rejon Ignacy)
Świętochłowice (urban)	PL22A	1001241487601	1	Two hoisting towers no. I and II of the former Polska mine and their surroundings within the plot
Tarnowskie Góry (urban)	PL228	1001241451304	2	Former ore mine
Tarnowskie Góry (urban)	PL228	1001241451304	2	City park with its components including topography, mainly the area of the iron ore mine with preserved warps on the shafts
Zabrze (urban)	PL229	1001241477801	1	Building complex of the former "Królowa Luiza" mine
Zabrze (urban)	PL229	1001241477801	1	Building of the former workers' hotel of the Ludwik mine
Zabrze (urban)	PL229	1001241477801	1	"Ludwik" mine development complex
Zabrze (urban)	PL229	1001241477801	1	The "Liberation" shaft and the main gallery in seam 510 of the former "Królowa Luiza" mine
Zabrze (urban)	PL229	1001241477801	1	Complex of buildings and headings of the former "Guido" mine
Zabrze (urban)	PL229	1001241477801	1	Excavations of the former Luiza and Zabrze-Bielszowice mines
Zabrze (urban)	PL229	1001241477801	1	Cloakroom and mining bath building on the site of the former Castellengo hard coal mine
Zabrze (urban)	PL229	1001241477801	1	Fall corridor no. 1 at level 320—part of the complex of buildings and road pits of the
Zabrze (urban)	PL229	1001241477801	1	Former "Guido" hard coal mine

Appendix C

Forms of nature protection that may be established to protect valuable landscapes: landscape parks, protected landscape areas and natural and landscape complexes in municipalities of Śląskie Voivodship (source: Central Register of Nature Conservation Forms of Republic of Poland).

Table A3. Landscape parks in municipalities of Silesian Voivodship (source: own elaboration based on: General Directorate for Environmental Protection. Central Register of Nature Protection Forms).

Landscape Park	Municipality (Administrative Type)	NUTS 3	LAU	DEGURBA
Landscape Park "Cysterskie Kompozycje Krajobrazowe Rud Wielkich"	Sośnicowice (urban–rural)	PL229	1001241470506	3
	Racibórz (urban)	PL227	1001241491101	2
	Jejkowice (rural)	PL227	1001241491203	2
	Suszec (rural)	PL22C	1001241511006	2
	Pilchowice (rural)	PL229	1001241470504	3
	Żory (urban)	PL227	1001241497901	1
	Kuźnia Raciborska (urban–rural)	PL227	1001241491105	2
	Nędza (rural)	PL227	1001241491106	3
	Rybnik (urban)	PL227	1001241497301	1
	Knurów (urban)	PL229	1001241470501	2
	Orzesze (urban)	PL22C	1001241510803	2
	Kornowac (rural)	PL227	1001241491102	3
	Lyski (rural)	PL227	1001241491204	3
	Gaszowice (rural)	PL227	1001241491202	2
	Czerwionka-Leszczyny (urban–rural)	PL227	1001241491201	2

Table A3. *Cont.*

Landscape Park	Municipality (Administrative Type)	NUTS 3	LAU	DEGURBA
Załęczański Landscape Park	Lipie (rural)	PL224	1001241460603	3
Lasy Nad Górną Liswartą Landscape Park	Blachownia (urban–rural)	PL224	1001241460401	2
	Wręczyca Wielka (rural)	PL224	1001241460609	3
	Boronów (rural)	PL228	1001241450702	3
	Koszęcin (rural)	PL228	1001241450706	3
	Woźniki (urban–rural)	PL228	1001241450708	3
	Ciasna (rural)	PL228	1001241450703	3
	Przystajń (rural)	PL224	1001241460608	3
	Panki (rural)	PL224	1001241460606	3
	Starcza (rural)	PL224	1001241460416	3
	Konopiska (rural)	PL224	1001241460407	3
	Herby (rural)	PL228	1001241450704	3
	Kochanowice (rural)	PL228	1001241450705	3
Orlich Gniazd Landscape Park	Częstochowa (urban)	PL224	1001241466401	1
	Dąbrowa Górnicza (urban)	PL22B	1001241506501	1
	Janów (rural)	PL224	1001241460403	3
	Kroczyce (rural)	PL22B	1001241501604	3
	Łazy (urban-rural)	PL22B	1001241501605	3
	Mstów (rural)	PL224	1001241460410	3
	Niegowa (rural)	PL224	1001241460903	3
	Ogrodzieniec (urban–rural)	PL22B	1001241501606	2
	Olsztyn (rural)	PL224	1001241460412	3
	Pilica (urban–rural)	PL22B	1001241501607	3
	Poczesna (rural)	PL224	1001241460413	2
	Włodowice (rural)	PL22B	1001241501609	3
	Zawiercie (urban)	PL22B	1001241501602	2
	Żarki (urban-rural)	PL224	1001241460905	3
	Żarnowiec (rural)	PL22B	1001241501610	3
Stawki Landscape Park	Przyrów (rural)	PL224	1001241460414	3
	Janów (rural)	PL224	1001241460403	3
	Mstów (rural)	PL224	1001241460410	3
Beskidu Małego Landscape Park	Gilowice (rural)	PL229	1001241476601	1
	Kozy (rural)	PL225	1001241440207	2
	Żywiec (urban)	PL225	1001241441701	2
	Łękawica (rural)	PL225	1001241441707	2
	Bielsko-Biała (urban)	PL225	1001241446101	1
	Porąbka (rural)	PL225	1001241440208	2
	Łodygowice (rural)	PL225	1001241441708	2
	Wilkowice (rural)	PL225	1001241440210	2
	Czernichów (rural)	PL225	1001241441702	3
Żywiecki Landscape Park	Świnna (rural)	PL225	1001241441713	2
	Rajcza (rural)	PL225	1001241441711	3
	Ujsoły (rural)	PL225	1001241441714	3
	Jeleśnia (rural)	PL225	1001241441704	3
	Radziechowy-Wieprz (rural)	PL225	1001241441710	2
	Węgierska Górka (rural)	PL225	1001241441715	2
	Milówka (rural)	PL225	1001241441709	3

Table A3. *Cont.*

Landscape Park	Municipality (Administrative Type)	NUTS 3	LAU	DEGURBA
Beskidu Śląskiego Landscape Park	Węgierska Górka (rural)	PL225	1001241441715	2
	Szczyrk (urban)	PL225	1001241440201	2
	Jasienica (rural)	PL225	1001241440205	3
	Jaworze (rural)	PL225	1001241440206	2
	Brenna (rural)	PL225	1001241440304	3
	Bielsko-Biała (urban)	PL225	1001241446101	1
	Buczkowice (rural)	PL225	1001241440203	2
	Wilkowice (rural)	PL225	1001241440210	2
	Radziechowy-Wieprz (rural)	PL225	1001241441710	2
	Wisła (urban)	PL225	1001241440303	2
	Milówka (rural)	PL225	1001241441709	3
	Ustroń (urban)	PL225	1001241440302	2
	Lipowa (rural)	PL225	1001241441706	2
	Goleszów (rural)	PL225	1001241440307	3
	Istebna (rural)	PL225	1001241440309	3

Table A4. Protected landscape areas in municipalities of Silesian Voivodship (source: own elaboration based on: General Directorate for Environmental Protection. Central Register of Nature Protection Forms).

Protected Landscape Areas	Municipality (Administrative Type)	NUTS 3	LAU	DEGURBA
Przełajka Protected Landscape Area	Siemianowice Śląskie (urban)	PL22A	1001241487401	1
Dobra Wilkoszyn Protected Landscape Area	Jaworzno (urban)	PL22B	1001241506801	1
Góra Zamkowa Protected Landscape Area	Bedzin (urban)	PL22B	1001241500101	1
Wyżyny Miechowskiej Protected Landscape Are	Wodzisław (urban)	PL227	1001241491504	2
	Żarnowiec (rural)	PL22B	1001241501610	3
Meandry Rzeki Odry Protected Landscape Area	Krzyżanowice (rural)	PL227	1001241491104	3
Podklepie Protected Landscape Area	Bestwina (rural)	PL225	1001241440202	2
	Czechowice-Dziedzice (urban)	PL225	1001241440204	2
Cieszyńskie Pogórze Protected Landscape Area	Cieszyn (urban)	PL225	1001241440301	2
Potoku Ornontowickiego łącznie z dopłwami Protected Landscape Area	Ornontowice (rural)	PL22C	1001241510804	2
Potoku Leśnego łączenie z dopływami Protected Landscpe Area	Ornontowice (rural)	PL22C	1001241510804	2
Potoku Z Bujakowa łączenie z dopływani Protected Landscape Area	Ornontowice (rural)	PL22C	1001241510804	2
Potoku Ląkowego łączenie z dopływani Protected Landscape Area	Ornontowice (rural)	PL22C	1001241510804	2
Potoku od Solarni łączenie z dopływani Protected Landscape Area	Ornontowice (rural)	PL22C	1001241510804	2
Otuliny Załęczańskiego Parku krajobrazowego Protected Landscape Area	Lipie (rural)	PL224	1001241460603	3
Otulina Parku Krajobrazowego Orlich Gniazd i Parku Krajobrazowego Stawki Protected Landscape Area	Zawiercie (urban)	PL22B	1001241501602	2
	Łazy (urban–rural)	PL22B	1001241501605	3
	Dąbrowa Górnicza (urban)	PL22B	1001241506501	1
	Ogrodzieniec (urban–rural)	PL22B	1001241501606	2
	Żarnowiec (rural)	PL22B	1001241501610	3
	Kroczyce (rural)	PL22B	1001241501604	3
	Sławków (urban)	PL22B	1001241500108	2
	Pilica (urban–rural)	PL22B	1001241501607	3
Wzgórze Doroty, Lasek Grodziecki Protected Landscape Area	Będzin (urban)	PL22B	1001241500101	1

Table A5. Nature and landscape complexes in municipalities of Silesian Voivodship (based on: General Directorate for Environmental Protection. Central Register of Nature Protection Forms).

Nature and Landscape Complexes	Municipality (Type)	NUTS 3	LAU	DEGURBA
Szopienice-Borki	Katowice (urban)	PL22A	1001241486901	1
Las Murckowski Buczyna	Katowice (urban)	PL22A	1001241486901	1
Źródliska Kłodnicy	Katowice (urban)	PL22A	1001241486901	1
Dolina Wapienicy	Bielsko-Biała (urban)	PL225	1001241446101	1
Cygański Las	Bielsko-Biała (urban)	PL225	1001241446101	1
Sarni Stok	Bielsko-Biała (urban)	PL225	1001241446101	1
Gościnna Dolina	Bielsko-Biała (urban)	PL225	1001241446101	1
Żabie Doły	Bytom (urban), Chorzów (urban), Piekary Śląskie (urban)	PL228	1001241456201	1
		PL22A	1001241486301	1
		PL228	1001241457101	1
Miechowicka Ostoja Leśna	Bytom (urban)	PL228	1001241456201	1
Suchogórski Labirynt Skalny	Bytom (urban)	PL228	1001241456201	1
Uroczysko Buczyna	Chorzów (urban)	PL22A	1001241486301	1
Bociek	Lubomia (rural)	PL227	1001241491507	2
Wielikąt	Lubomia (rural)	PL227	1001241491507	2
Park w Reptach in Dolina rzeki Drzamy Zbrosławice	Tarnowskie Góry (urban)	PL228	1001241451304	2
Doły Piekarskie	Tarnowskie Góry (urban)	PL228	1001241451304	2
Lasek Miejskiw Błogocicach	Cieszyn (urban)	PL225	1001241440301	2
Bluszcze na Górze Zamkowej	Cieszyn (urban)	PL225	1001241440301	2
Dolina Jamny	Mikołów (urban)	PL22C	1001241510802	2
Wzgórze Kamionka	Mikołów (urban)	PL22C	1001241510802	2
Uroczysko Sadowa Góra	Jaworzno (urban)	PL22B	1001241506801	1
Jaworze	Jaworze (rural)	PL225	1001241440206	2
Dolina Lipinki	Świętochłowice (urban)	PL22A	1001241487601	1
Wzgórze Gołonoskie	Dąbrowa Górnicza (urban)	PL22B	1001241506501	1
Kaplicówka	Skoczów (urban–rural)	PL225	1001241440310	2
Pasieki	Miasteczko Śląskie (urban)	PL228	1001241451302	2
Góra Bucze	Brenna (rural)	PL225	1001241440304	3

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