

THE LAND USE OF DECOMMISSIONED COAL MINES AREAS IN THE UPPER SILESIAN AGGLOMERATION (POLAND)

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Abstract

The transformation of post-industrial areas of coal mines has been going on for over 80 years. Despite years of discussion and various international experiences, effective instruments and best practices for brownfields are still being sought. Today, in the face of rapidly changing social and environmental conditions, it is necessary to rethink the future of coal regions. To meet the challenges ahead, all experiences must be critically analysed and confronted with land development. This paper shows the main directions of decommissioned coal mines areas in the Silesian Agglomeration. For this purpose, it was necessary to identify closed mines' areas and recognise they present land use. The research is based on a query of archival and library materials, field research, the author's classification of land use, and cartographic and quantitative research. The study shows that the main direction of land use is industry (about 48.3%) and services (24.4%). Furthermore, until today more than half of the post-industrial land is undeveloped by mining facilities, and only about 7.4% of it is prepared for potential investment.

Keywords: Post-mining areas; Re-use of brownfields; Revitalisation of post-industrial areas.

1. INTRODUCTION

The problem of the transformation of coal mines' post-industrial areas began in Western Europe (France – Nord-Pas de Calais; Germany – Ruhr area; Spain – Asturias; Great Britain – North West, North East, Yorkshire and Humberside, West Midlands, East Midlands, South West, South East) in the early 1950s. The decision to abandon coal mining caused the decline of heavy industry and contributed to an economic, social and environmental crisis. Due to the strategic and economic importance of coal regions, their revitalisation has become nationally significant and poses an enormous challenge to public authorities, trade unions and companies [59].

The measures taken by governments were aimed at mitigating the effects of the mining restructuring process and creating a new image for mining regions. Their common element was the establishment of a

dedicated institution responsible for reclamation with regional/extra-regional scope, endowed with financial resources and fostering solid cooperation between the public and private sectors [47].

A well-known example of a successful revitalization post-mining region is the Internationale Bauausstellung (IBA) Emscher Park (1989–1999). The federal government decided to implement this experimental regional operational programme due to the lack of satisfactory results of the mining restructuring in the Ruhr area that had been carried out since the 1960s. The planned activities included more than 120 projects with different themes that helped to transform an industrial region into a cultural and economic one [27, 49]. The experience gained from the IBA Emscher Park programme has been used by many other German regions, including traditional industrial regions such as Lower Lusatia (IBA Furst Pucler Land) or Dessau-Wörlitz-Bitterfeld (Industrielles Gartenreich) [45].

But not all regions were as successful in overcoming the problems that were piling up. Especially for smaller regions, recovery from a deep crisis has been a long and painful process until now [60]. Despite many years of discussions and various international experiences, effective tools and best practices for brownfields are still being sought. Each area is unique and is in different legal, environmental, social, economic and spatial circumstances. Therefore, what is considered a model solution in one country may not be implementable elsewhere [54]. Hence, it is important to know the local conditions and effective methods for the remediation and revitalisation of post-industrial areas.

Today, in the face of intensively changing social and environmental conditions, it is necessary to rethink the future of coal regions. The continuation of the transformation process of post-industrial mining areas is inevitable due to a decrease in coal resources [33, 51] and a strong international climate policy [11, 13]. Consequently, the number of active facilities will gradually decrease, and a large number of new post-industrial areas will appear in their place.

Going through the entire transformation process requires preparation of suitable strategies, long-term plans and financial instruments to reduce the negative effects of the transformation. Their importance was highlighted by the “Solidarity and Just Transition Silesia Declaration”, issued at the 2018 Katowice Climate Conference [4]. In response to the challenge facing the EU members, the European Commission has established the “Just Transition Mechanism”. The idea behind this concept is to focus “on securing jobs and alleviating local social problems and other concepts like environmental justice, energy justice, climate justice, and intergenerational justice, take a more global and holistic perspective, also including non-humans as subjects of justice” [46].

However, the prepared concepts and programmes do not consider the number of spatial changes resulting from transformations [1–2, 10–15, 50, 59]. And yet, with the cessation of production, a transformation process begins, the purpose of which is to derive benefit from land use and to shape its positive impact on the social, natural and technical environment [17]. Therefore, an equally important goal of a “just transition” should be the revitalisation and effective management of post-industrial areas and protection of cultural heritage sites.

To meet the upcoming challenge, coal regions should critically analyse all previous experiences and confront them with the current development. On this

basis, they will be able to build new individual strategies and development plans, taking into account the local conditions to achieve the intended goals.

2. POST-MINING TRANSFORMATION IN POLAND

The restructuring of the mining sector in Poland was directly related to the general political and economic changes that began in 1989. The transformation process was part of the reforms that initiated the transition from an inefficient, centrally controlled economy to a free market economy. The main goal of the restructuring was to increase the productivity and profitability of the mining sector. To this end, mining companies were forced to reduce employment, cut back on coal production and close the least profitable mines. Together with the adjustment of production to demand, investments in infrastructure and debt reduction, mining would become an essential part of the Polish economy [32, 37].

The transformation process seemed to be more difficult for Poland compared to Western European countries due to the contemporary political instability, strong social tensions, modest financial resources and the lack of comparable experiences in other post-communist countries. The government was forced to constantly experiment. As a result, Poland achieved most of its goals and a steady economic growth, but the socioeconomic and environmental costs were very high [59].

An important factor that exacerbated the growing crisis was the concentration of coal mining in a highly urbanised and populated area. When the reforms began, 70 operating coal mines in Poland produced over 147 million tonnes of the ‘black gold’ annually [33]. Today, this number has decreased fourfold, and production is 43% lower than in the early 1990s [33]. The explosion of large amounts of brownfields both in city centres and on the outskirts (especially in the first decade) has led to a spatial crisis and the question of how to manage these areas.

The greatest concentration of negative issues related to this crisis can be observed in the Upper Silesian Agglomeration, which covers the northern part of the Silesian Coal Basin – one of the oldest and largest coal regions in the Europe (Fig. 1). It is the most populated and urbanised region in Poland with over 2 million inhabitants and an average population density of about 1440 people/km² [6]. The development of the Upper Silesian Agglomeration is connected with the rich deposits of hard coal, zinc, lead and iron

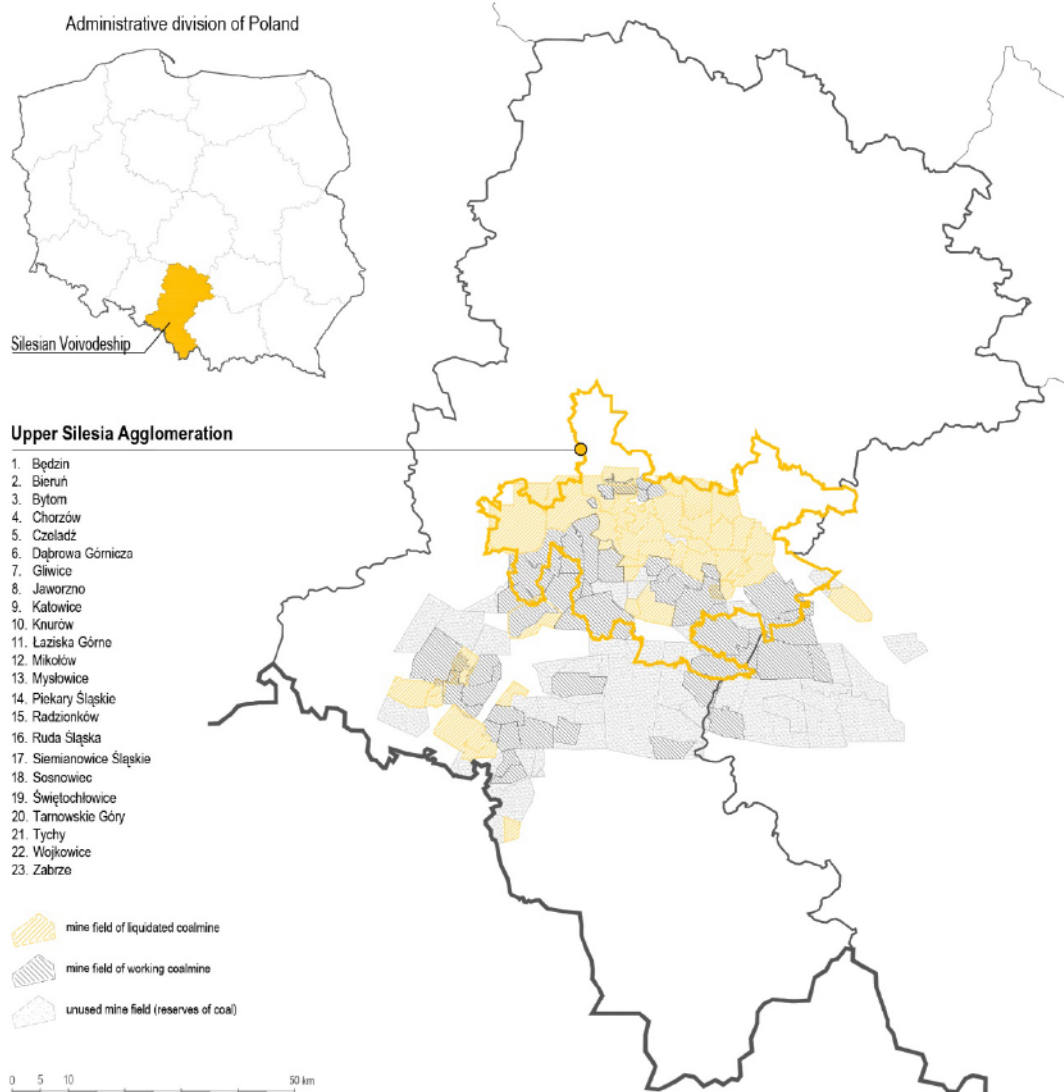


Figure 1.
Silesian Coal Basin located in Silesian Voivodeship. Source: author study

ores, mined since the 14th century [16]. At the end of the 19th century, a dynamic industrial development began here, which continued until the 1980s. As a result of the transformation process that commenced in Silesia in the early 1990s, the number of employees in the mining sector has fallen from about 400,000 to less than 100,000 [62], the population has decreased by 5.8% [6], and thousands of hectares of brownfield sites have appeared.

In the Upper Silesian Agglomeration, activities related to the adaptation of post-industrial areas, particularly those connected with mining activities, have been undertaken for over 30 years. During this period, rich experience has been gathered in reclamation, restructuring and revitalisation of brownfield sites. At

the same time, this experience has shown that the transition from plans to their implementation is a long, hard and not always fully effective process.

Significant scientific output and practical achievements related to the transformation of post-industrial areas in the Silesian Agglomeration are credited to the Industrial Architecture Division employees at the Faculty of Architecture of the Silesian University of Technology. Their research and scientific projects carried out in the 1980s and 1990s under the supervision of T. Gawłowski and then N. Juzwa covered planning as well as urban and architectural problems of post-industrial areas, including mining areas [31, 34–35, 43–44, 55–58]. Additionally, they developed numerous practical proposals for transformations of industrial

Table 1.
Classification of the land use of coal mines' post-industrial areas in the Upper Silesian Agglomeration

	Land use	Description
UNDEVELOPED AREAS	mining area	Areas used as coal mines or areas used to protect them.
	abandoned areas	Land which was left unsecured by the owners and continued to be unused, gradually devastated and degraded. Consequently, these areas may have a negative and hazardous impact on the surroundings.
	brownfield wasteland	Areas where reclamation has not been properly carried out (or has not been completed) and areas where elements of construction facilities and technical infrastructure have been left (e.g. in the form of rubble). These sites may be highly contaminated or pose a high environmental risk.
	wasteland	Areas where the land has been cleaned up and the proper reclamation is carried out. Additionally, as a result of natural succession, weathering, leaching and sedimentation, the expansion of nature takes place.
	wooded areas, forest areas	
	investment areas	Areas where proper reclamation has been carried out, the site has been cleaned up, and the technical infrastructure has been prepared for a potential investment (e.g. post-industrial areas of the 'Bogucice' Shaft and the Katowice Special Economic Zone in the area of the 'Powstańców Śląskich' Coal Mine). They also include areas where construction works related to the new form of use will be carried out (e.g. the Climbing and Strength Sports Center in Bytom).
DEVELOPED AREAS	industrial areas	Land used for industrial buildings and manufacturing services, logistics, wholesale trade, warehousing and storage facilities, etc., along with the necessary infrastructure.
	service areas	Land used for administrative services, cultural and health services, commercial services, social services (educational buildings, nursing homes, etc.), entertainment and recreation services (entertainment and sports halls) and others, along with the necessary infrastructure.
	green and recreation areas	Land used as parks and other areas of arranged greenery, recreation and entertainment services (playgrounds, stadiums, sports fields, swimming pools, individual recreation areas, etc.), along with the necessary infrastructure.
	low-intensity residential areas	Areas used for low-intensity residential development or residential-service development (in particular single-family housing).
	high-intensity residential areas	Land used for high-intensity residential development or residential-service development (especially multi-family housing).
	land transport	Land used for roads, railway, car parks, etc.
	other	Other use of land

Source: author study

areas in the context of their immediate surroundings ("Barbara-Chorzów" Coal Mine, "Prezydent" Coal Mine, "Siemianowice" Coal Mine, "Katowice" Coal Mine, "Murcki" Coal Mine, "Saturn" Coal Mine, "Sosnowiec" Coal Mine and "Gliwice" Coal Mine).

With the end of the '90s and the acquired local experience, the researchers began to look for transformation models and classification methods for post-industrial areas [3, 7–9, 17–20, 26, 38, 41, 45, 47–48, 61]. The analysis of selected cases led to the identification of possible conditions for the potential use of post-industrial facilities and areas, and possible directions of their transformation. These studies laid the foundations for the proposals for practical tools for the development of post-industrial areas according to their specifics and projected use. The conference "Innovative solutions for the revitalization of degraded areas", organised by the Institute for Ecology of Industrial Areas in Katowice and the Research and Supervisory Centre of Underground Mining in Łędziny (from 2007 to 2016), aimed to successively

present the achievements of scientific work [53] as well as practical and organisational solutions for a sustainable development of brownfields.

The plans and strategies for the development of coal mines' post-industrial areas resulted in numerous implementations (Table 2), but those projects are of only local nature. Unlike in Germany, regional scale plans have never been fully implemented or realised in large part. Similarly, there has not been an attempt to build and implement a holistic system for transforming post-industrial areas that would include all process elements – from building databases on such areas, through planning regulations and designs, to their implementation. As a consequence, access to information on post-mining areas, their correct identification as well as the monitoring of rehabilitation and restructuring processes being carried out are made more difficult.

In recent years, there has been an increase in the interest in post-industrial transformation. Most of the research projects are summative, collecting the

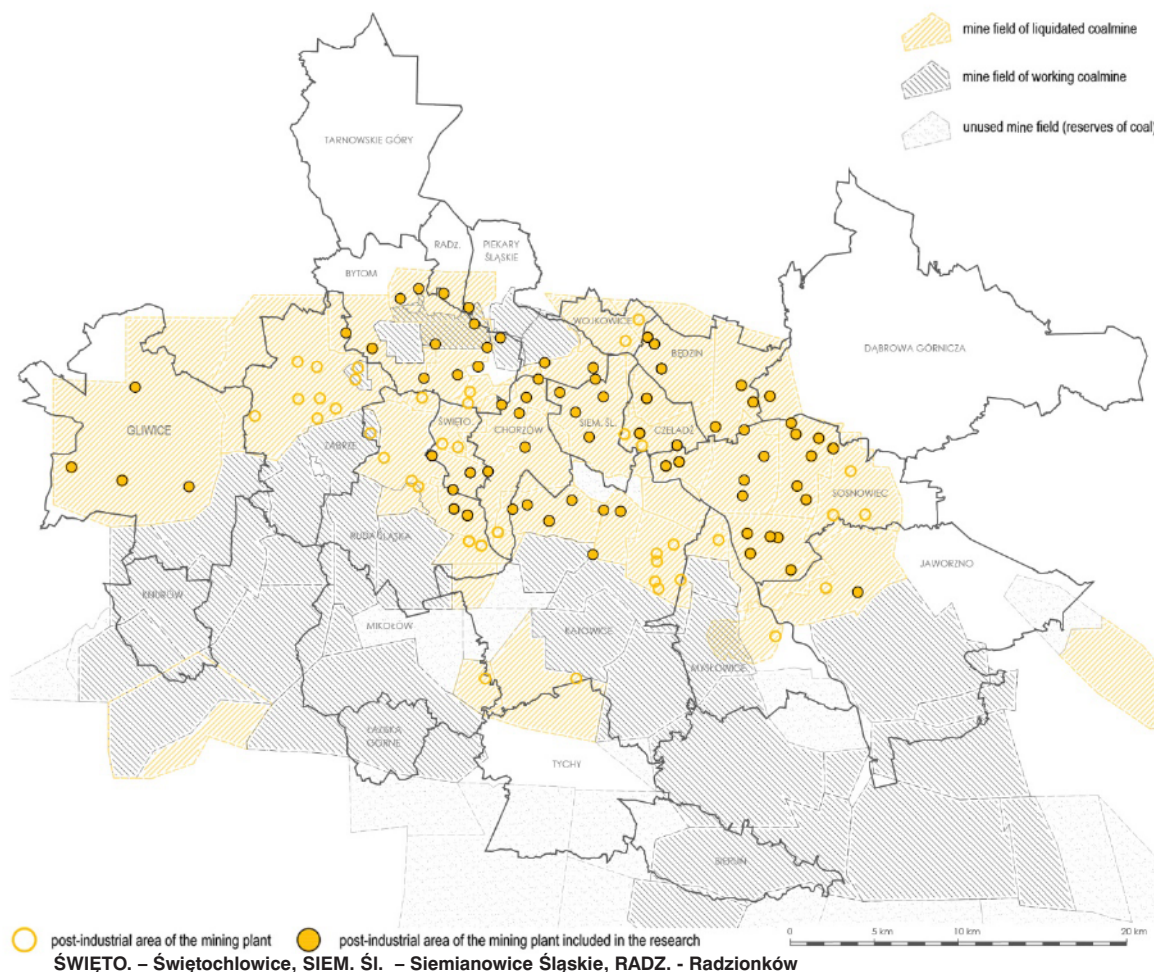


Figure 2
Post-industrial areas of decommissioned mining plants in the Upper Silesian Agglomeration. Source: author study

experience of restructuring and revitalisation [21–22, 29–30, 39–40, 52, 62]. On the other hand, they try to define new methods of conduct or recommendations in the process of spatial management [5, 25, 28, 36]. Simultaneously, in such a wide literature, it can be noticed that the research results are based only on selected ‘positive’ examples. Information about the lack of actions taken or the effects of unrealised plans is practically ignored. There is also a noticeable lack of broader research illustrating the scope and scale of the activities undertaken, which would fully present the complexity of the problem.

3. RESEARCH AIMS, SCOPE AND METHODS

The purpose of this paper is to examine the present land development of decommissioned coal mines’

post-industrial areas in the Silesian Agglomeration. The research was based on:

- a query of archival and library materials (obtained from the Archives of the State Mining Authority in Katowice, libraries, mining enterprises and other state institutions – municipal offices, the Central Statistical Office, etc.)
- identification of the coal mines’ post-industrial areas, which were decommissioned in the period from 1990 to 2019;
- field research with photographic inventory, which took place from October 2020 to March 2021;
- the author’s classification of land use, taking into account the present development progress of mine decommissioning and the condition of the environment (Table 1);
- cartographic and quantitative research based on

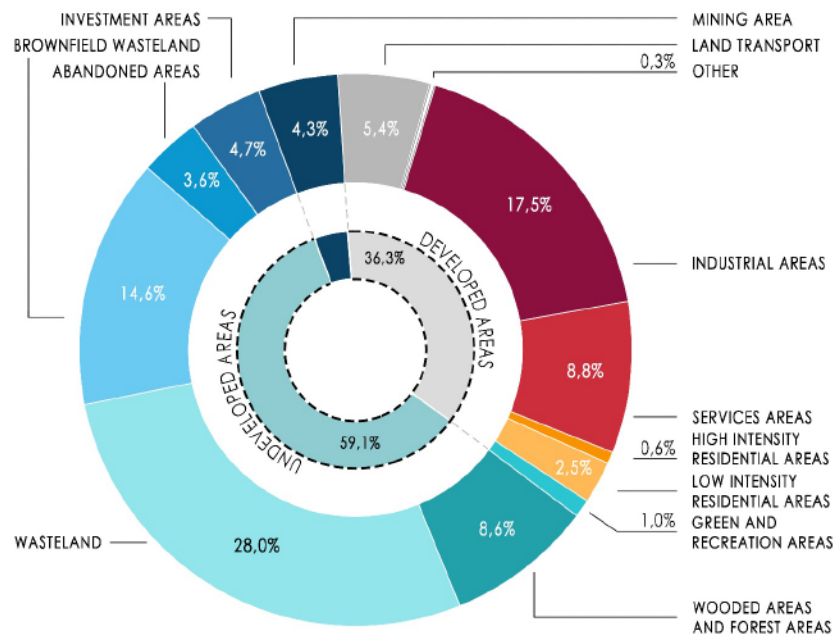


Figure 3
Post-industrial areas of decommissioned mining plants in the Upper Silesian Agglomeration. Source: author study

open-access geographic information systems [23–24, 42].

All studies are estimates and may differ slightly from reality.

The study examined was post-industrial areas of decommissioned coal mines between 1990 to 2019, whose obtained archival documentation allowed their correct identification and delimitation as of 1 October 2020. The study did not cover landfill sites and spoil tips located outside a mining plant's area. The research object was limited to 78 post-industrial areas located in 20 mining fields with a total area around 857.2 hectares. (Fig. 2).

4. LAND USE OF DECOMMISSIONED COAL MINES' POST-INDUSTRIAL AREAS

Transformation of decommissioned mines' post-industrial areas is a complicated and long-term process. Research has shown a wide variety of their use (Fig. 3) – from maintaining their original function (of a mining area), to their abandonment and leaving them aside (undeveloped areas), to their reuse (developed areas). However, this picture and proportions differ from those presented in the literature.

Nowadays, about 4.3% of the industrial areas of mining facilities continue to be used in their original

form, mostly for strategic and technological reasons. It should be remembered that mines throughout the coal basin operate like a system of communicating vessels. The areas left behind are used to provide adequate safety conditions (e.g. gas and water) or the possibility of alternative access to neighbouring mines. Another reason is the time itself that has passed since the plant was decommissioned. In areas where mining was carried out relatively recently, demolition or reclamation work may be carried out (e.g. the “Centrum” coal mine). The less common reason is the purchase of a mining site by individual investors in order to continue mining (e.g. the Mining Plant Eko-Plus Sp. z o.o. in the “Powstańców Śląskich” Coal Mine and the Mining Plant “Siltech” Sp. z o.o. in the “Jadwiga” Coal Mine).

The study of the land use structure has shown that more than half of the post-industrial areas of the mining sites have remained undeveloped (Fig. 3). As a result of natural succession (intentional or spontaneous), they are characterised by high ecological diversity. These areas cannot be treated in the same way, bearing in mind the extent of remaining technical infrastructure, waste and the level of contamination (Fig. 4).

Undeveloped areas are present at all the sites studied (Fig. 3), but their proportion varies depending on the objectives set by the restructuring companies and the approach to the process of their transformation.



Figure 4.
Example of undeveloped areas. Source: author's photo, November 2020 – January 2021
A – wasteland areas (post-industrial areas of 'Jan Kanty' Coal Mine),
B – wooded areas, forest areas (post-industrial areas of 'Kleofas' Coal Mine),
C – brownfield wasteland areas (post-industrial areas of 'Szombierki' Coal Mine),
D – abandoned areas (post-industrial areas of 'Paryż' Coal Mine).

Based on the way in which the decommissioning of a mining facility was carried out and the land was reclaimed, we can distinguish three groups of land use:

- land prepared for investment (investment areas – 7.3%);
- biologically active land, where natural succession has taken place after the decommissioning performed (wasteland – about 47.4%; wooded areas, forest areas – about 14.3%)
- abandoned or uncleared land, where numerous environmental problems may exist (brownfield wasteland – about 24.8%; abandoned areas – about 6.0%).

Developed areas represent approximately 36,3% of all the post-industrial areas of mines studied. They are characterised by a very low intensity of development and a high proportion of accompanying transport infrastructure (Table 2). A considerable part of

them (about 48.3%) is used as industrial areas, where facilities such as production plants, warehouses, logistics centres and industrial parks are present. The second direction of post-industrial land reuse is services (24.4%). These areas are mainly used for commercial, educational and cultural purposes.

Residential, green and recreational areas make up a relatively small percentage of developed post-industrial land of former mines. It is about 7% for single-family residential areas, 2% for multifamily residential areas, and 3% for areas with a high percentage of biologically active land. This situation may be a result of the negative attitude of potential users towards post-industrial areas. On the other hand, investors fear additional and unforeseen costs (e.g. reinforcement of unstable soil, environmental pollution and hidden infrastructure), which directly affect the price of housing and thus reduce the potential demand.

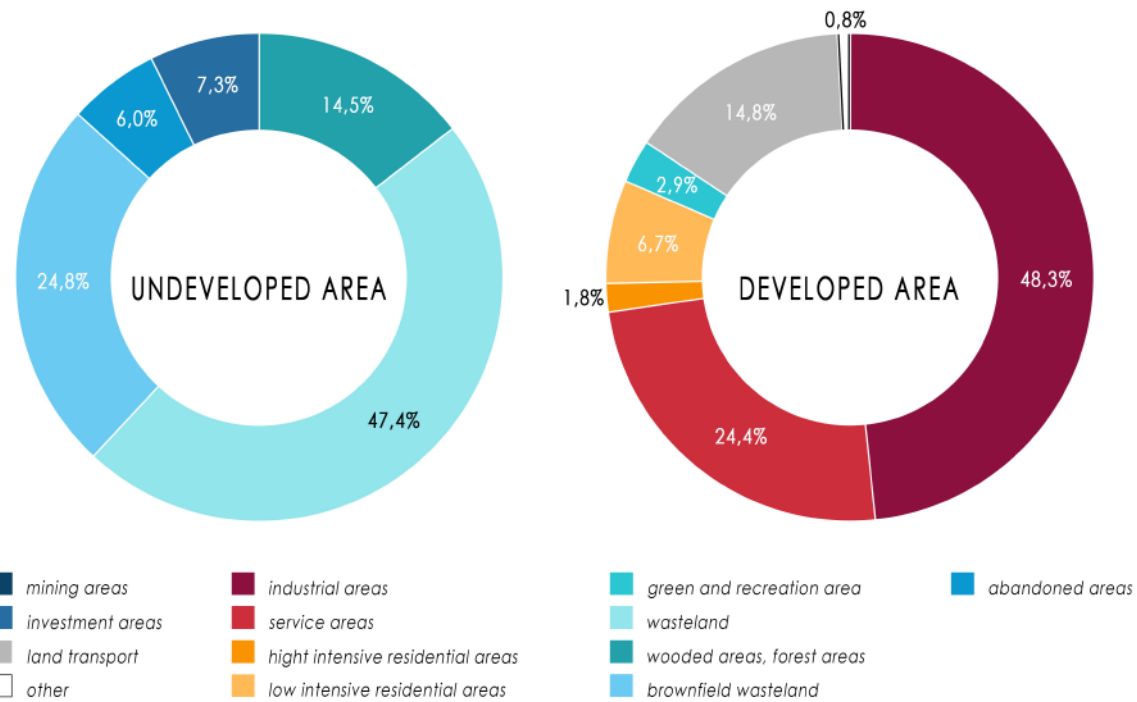


Figure 5.

Use of decommissioned coal mines' post-industrial areas in the Upper Silesian Agglomeration — developed and undeveloped areas.

Source: author study

In general, three models of new development can be distinguished:

- ad hoc use and adaptation of existing infrastructure (buildings as well as technical and communication infrastructure);
- a targeted adaptation of selected buildings (usually to emphasise historical values);
- the complete removal of existing infrastructure, land reclamation and new development.

The first model is characteristic of spontaneous transformations, especially for industrial purposes. It allows the use of a large part of the existing infrastructure and current planning regulations. Deliberate adaptation of selected buildings, covered by the second model, is usually used to highlight their historical values. The last method is characteristic for planned projects.

Land use differs between particular mining sites and the cities in which they are located (Fig. 6). Many factors influence the reuse of post-industrial areas of decommissioned mining plants. They relate to the site's spatial, environmental, economic, social, cultural and legal characteristics and its correlations with the surroundings. At the same time, they determine the transformability of a given area [17]. The study shows that the degree of redevelopment is correlated

with the location of a post-mining area in the structure of the Upper Silesian Agglomeration. Areas located in central city districts and in highly urbanised structures are redeveloped faster and at a higher percentage ("Gottwald" Coal Mine, "Katowice" Coal Mine) than areas located in the periphery ("Rozalia" Shaft of the "Siemianowice" Coal Mine, "Grodziec" Coal Mine). Impact on the potential of an area to be transformed is exerted by the transport accessibility and connections to a neighbouring area. For example, post-mining areas with direct access to expressways are used as warehousing and logistics centres ("East" Shaft of the "Niwka-Modrzejów" Coal Mine, "Łabędy" Shaft No. 5 of the "Gliwice" Coal Mine), whereas post-mining sites adjacent to residential areas are used as service areas or host facilities supporting the surrounding functions ("Stanisław" Shaft of the "Sosnowiec" Coal Mine, "Ksawery" open pit of the "Paryż" Coal Mine).

The spatial planning policy of respective cities also determines the direction in which the post-industrial areas of mines are transformed. It can be observed that the preferred direction of transformation in Katowice and Jaworzno is to create service areas, and for Będzin it is residential (low and high intensity) development. In Sosnowiec and Chorzów, industrial areas make up the largest share of all redeveloped

Table 2.**Selected transformation examples of mining plants' post-industrial areas in the Upper Silesian Agglomeration**

Function	Location	Name	Year	Area
business, industrial and technology parks	Bytom Sosnowiec Dąbrowa G.	Katowice Special Economic Zone	1996	17.05 ha / ~ 5 ha / 8.29 ha
	Gliwice	Education and Business Center – “Nowe Gliwice”	2006–2008	23.67 ha
	Ruda Śląska Świętochłowice	Incubator of Technological and Service Innovations – Architecture and Construction	2007–2008	1.35 ha
	Sosnowiec	Sosnowiec Science and Technology Park	2011–2012	1.57 ha
	Jaworzno	Business Center – Jaworzno Industrial Park	–	0.34 ha
cultural and educational	Bytom	Rozbark Dance and Movement Theatre	2011–2014	0.40 ha
	Czeladź	Contemporary Art Gallery “Elektrownia”	2007–2013	0.73 ha
	Katowice	Silesian Museum	2006–2015 2012–	6.1 ha
	Katowice	NOSPR** headquarters	2008–2014	4.32 ha
	Katowice	“Wilson” Shaft Gallery	1998	2.32 ha
	Siemianowice Śl.	Tradition Park	2009–2011	1.80 ha
	Świętochłowice	Coal Mine “Polska” towers	2015	0.57 ha
	Zabrze	Coal Mining Museum***	1981–	-
recreation and sport	Bytom	Climbing and Strength Sports Center (under construction)	2018–	0.39 ha
	Chorzów	The hoisting tower of the “Prezydent” shaft with the “Szttygarka” complex	2009–2012	~ 5 ha
	Sosnowiec	Climbing centre – Poziom 450	2010–2012	0.36 ha
residential	Będzin	Housing estate “Podskarpie”	2015	~ 12 ha
	Będzin	Housing estate “Brzozowica”	2016	2.08 ha
	Katowice	Housing estate “First district” (under construction)	2019–	~ 7 ha
	Katowice	Housing estate “Oak Terraces”	2007–2014 2018–	5.56 ha
other	Katowice	Silesia City Center	2005	20.12 ha
	Sosnowiec	District Prosecutor's Office in Sosnowiec	2017–2019	0.89 ha
	Zabrze	Shaft “Maciej”	2007–2013	1.19 ha

* Dabrowa G. – Dabrowa Górnicza, ** NOSPR – National Polish Radio Symphony Orchestra,

***The Coal Mining Museum consists of: the Historic Guido Coal Mine, the workings of the Queen Louise Mine, the Main Key Hereditary Adit, Park 12C, Military Technology Park

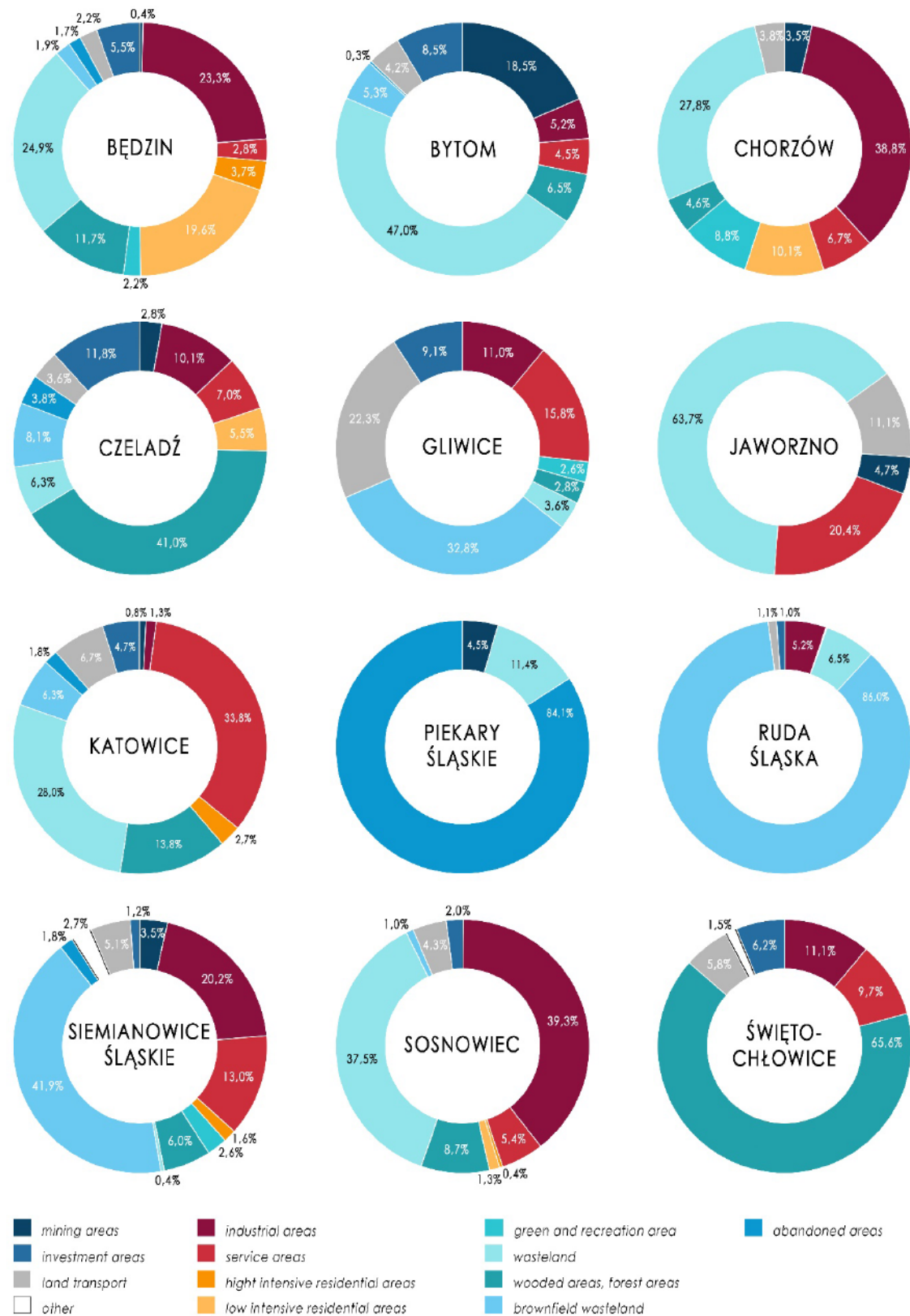
Source: author study

areas. Most post-industrial areas of closed mines are covered by Local Spatial Development Plans. They reflect the development strategy proposed by the cities and define the intended land use. Nevertheless, there is a risk that the proposed development directions will not be implemented due to the duration of the development process, the possibility of unexpected events, changes in ownership, and the size and diversity of the land, among other factors. Consequently, they may hinder the development of these areas and leave them undeveloped for a long time (“Rozbark” Coal Mine, “Kleofas” Coal Mine, “Powstańców Śląskich” Coal Mine). Therefore, these areas should be mapped in the planning docu-

mentation as areas requiring transformation/reclamation/rehabilitation or temporary use. In this way, all current conditions can be linked to the planned transformation strategy.

The research found that not all areas are coping at an equal level with the process of brownfield redevelopment (Fig. 6). The largest amount of undeveloped land (brownfields and abandoned areas) requiring intensive reclamation is located in Piekary Śląskie (95.5%) and Ruda Śląska (93.5%). In Bytom, Czeladź, Jaworzno, Katowice, Sosnowiec and Świętochłowice, over 40% of the surveyed areas are fallow land and forested areas.

In view of the changing environmental and climatic



conditions, the possibilities of using undeveloped land should be considered as an element of a given city's adaptation to climate change. Already today, more than 300 hectares of wasteland, forest and wooded areas can be used as a basis for building a system of blue-green infrastructure. Once reclamation is complete, the base can be expanded to include post-industrial and abandoned land (about 150 hectares). The once problematic areas can become an opportunity for further development of the region.

The results obtained in the described research will allow to assess in the next stage of the work whether the new development planned at the time of the mine's liquidation has been successfully implemented.

5. CONCLUSIONS

Attempts to reuse the post-industrial areas of mining plants in the Upper Silesian Agglomeration have been going on for 30 years. They apply to sites located in city centres and those on the outskirts. Since then, we have gathered extensive theoretical and practical experience related to reclaiming, restructuring and revitalising post-mining areas. However, not all the actions are effective. To this day, over half of the post-industrial areas of mining plants remain undeveloped, and only about 7.4% of them are prepared for a potential investment.

The main direction of land reuse is establishing industrial areas (about 48.3%) and service areas (24.4%). Residential, green and recreation areas constitute a relatively small percentage of land reuse. The proportions in the structure of redevelopment differ between particular mining sites and cities where they are located.

Influence on the reuse of post-industrial areas is exerted by numerous factors [17], but knowledge about them is the most crucial element in determining an investment decision. The widespread lack of information about contamination of land and technical infrastructure left under the surface as well as contradictory information obtained from different sources lead to the abandonment of any action.

Concerning the number and diversity of uses of mine sites, it is essential to create and frequently update extensive regional databases of post-industrial areas based on a unified methodology for their identification, valuation and qualification. Such a database would allow for the wide availability of knowledge about these sites and the possibility of their proper

analysis. A ranking of these sites should also be considered in terms of the degree of the environmental degradation threat, the infrastructure elements left behind and their potential use.

Another aspect of the proper management of post-mining sites is the need to establish an integrated development strategy for the whole region and implement a regional monitoring system to keep track of the degradation and rehabilitation of these sites. At present, some aspects concerning the development of post-mining areas are included in a number of planning documents (such as the City Development Strategy, the Municipality Study of Conditions and Directions of Spatial Development, Revitalisation Programmes). The general strategy would consolidate all planning activities dedicated to post-industrial areas and their sustainable development.

Today, undeveloped land can provide opportunities and new possibilities for further urban growth. Due to a good transport network and correlation with the neighbourhood, these areas have great investment potential for residential, service and production development. On the other hand, in the face of environmental and climatic change, we should consider transforming them into areas of sustainable environmental use.

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