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POST-INDUSTRIAL AREAS MANAGEMENT AND EVALUATION WITH A VIEW TO REDEVELOPMENT – CASE STUDY

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Purpose: The study focuses on the problem of redevelopment of post-industrial areas. Their location is often attractive, but potential investors are deterred by a lack of knowledge about the area or an unstable ownership situation. It is therefore necessary to collect information on the past of the area, its current state and the ongoing effects of its former use. The article is an example of a preliminary examination of unused land in order to determine the possibility of its re-use.
Design/methodology/approach: The scope of the study includes the identification of the main characteristics of the studied area.
Findings: The direction of redevelopment of the analyzed area was initially determined.
Practical implications: This study should be followed by a comprehensive analysis of the substances contained in the ground of the area in question and their impact on human health, planning of actions to neutralise any possible negative impact and an estimate of the costs of implementing such modifications.
Social implications: The development of the studied area will be an extension of the recreational functions of the adjacent nature and landscape complex.
Originality/value This article is a contribution to holistic research on the described area in order to give it valuable functions.

Keywords: Post-industrial area management, redevelopment.

Category of the paper: case study.

1. Introduction

The article concerns the issue of re-management of degraded post-industrial areas in GOP (Górnośląski Okręg Przemysłowy – Upper Silesian Industrial District). The paper emphasizes the need to collect full information about brownfields. It is important for the decision on the choice of land for re-development by a potential investor. Re-development, preceded by the elimination or minimization of the harmful effect of the area on the environment and human health, will contribute to increasing the economic, environmental or recreational attractiveness

of the given urban center. The study includes a preliminary diagnosis of a selected area degraded by the processing of non-ferrous metal ores, allowing to determine the directions of future re-development of the area.

One of the most negative effects of intensive development of heavy industry in the cities of the Upper Silesian Industrial District is the disturbance of the chemical balance of the natural environment (Kabata, and Pendias, 1989; Roztański, 1997). Reclamation of areas where industrial activity was conducted should have been planned and implemented long before the end of the plant's activity. Unfortunately, in Poland the traditions of reclamation are not long. The transformation of the socialist economy into a market economy in Poland resulted in the fact that many mining and metallurgy plants have ceased activities or significantly reduced their activities (Zagórska, 2014). Some areas used by the heavy industry became greenfield sites and mostly not reclaimed. The re-use of degraded areas significantly increases the economic, tourist or recreational attractiveness of the city, however it should be preceded by a long and costly reclamation process. These areas often have an attractive location, but potential investors choose new areas that are not burdened by the industrial past.

2. Factors affecting the choice of area for re-development

In GOP, mining plants are or were often located in centers of cities or districts. The areas which used to be the support area of mining and coal processing and processing of metal ores are often very extensive. Due to their location relatively close to the city center, they are attractive areas for building housing estates, detached houses, business, service or leisure zones. It is increasingly common to give them new functions. However, there are also areas that are abandoned or used to a minor extent. There are various reasons for this: high costs of their revitalisation, unregulated ownership status, presence of strong pollution and often difficult to adapt facilities.

Examples of properly made reclamation in other countries (Czech Republic – area degraded by J. Sverm mine in Most, area of Vrbenský plant, Germany – area of heap in Botrop, area in Neuss near Dusseldorf and other (Kasztelewicz, 2009)) and in Poland (area of Kleofas mine in Katowice, Bełchatów mine, area of Baildon ironworks in Katowice and other), show: among the factors important for investors, such as financial support (e.g. tax exemptions or tax incentives) or improving administrative procedures, the most important is the need to obtain complete information about the given area (Zagórska, 2014). The choice of the reclamation method and the success of their implementation is conditioned by internal and external factors of the area. Internal factors include the features of the area and its susceptibility to bringing it to use form. The group of these factors includes the size of the terrain, its shape, the type of activity that led to its degradation and the effects of this activity, the type of infrastructure

existing or on the site. The external factors include factors not directly related to the history and condition of the area. These include the location of specific objects in relation to the analyzed area (service, residential zones, city center or district, industrial plants, etc.), the way the area is communicated with other parts of the city, neighboring cities by means of roads, railways, bicycle paths, walking routes, etc., access to the media. Legal and social conditions are also external factors (Gorgoń et. al., 2014).

There are several limitations that make it difficult or even impossible to give a new function to a degraded site. Below there is a brief overview of selected problems related to land redevelopment.

1. Legal limitations. Physical degradation of land often makes the ownership status of the land unclear. Land re-parceling and selling individual plots of land can effectively hamper investment activities.
2. Land management. Land management plans do not always cover the whole degraded area.
3. Dumping sites on the area. On the areas where mining and coal or metal ores processing activities were carried out there can be solid waste heaps. The properties of the waste accumulated there and the pressure may lead, or have already led, to a state of incineration. Extinguishing a burning heap is expensive.
4. Harmful effects on health. Substances contained in the soil of a degraded area can have harmful or even fatal effects on human health. Before deciding on the direction of redevelopment it is necessary to test soil samples for harmful elements or compounds.
5. Lack of infrastructure. The existence of road infrastructure, utility infrastructure, or access to energy and communication media may be important in the selection of land for planned investments.
6. Incomplete data. The condition for a potential investor to be interested in the redevelopment of a post-industrial area is to prepare a detailed analysis which will document as accurately as possible the past of the area, the nature of the activities carried out on it and the consequences of such activities. The systems for collecting data on these areas are constantly being improved, but the issue of incomplete or dispersed information is one of the drawbacks of the area assessment process.
7. Social factory. Support or opposition of local communities to the planned investment may have a significant impact on the success of its implementation. Public consultations regarding expectations for the re-use of the site are advisable.

3. Characteristics of the area under analysis

In the area of the Upper Silesian Industrial District, post-industrial solid waste dumps (heaps) are a significant nuisance, which in total occupy over 2000 ha (Jędrzejczyk-Korycińska, and Roztański, 2015). Heaps associated with the processing of non-ferrous metal ores, such as zinc and lead, are one of the most onerous post-industrial effects. It pollutes groundwater, leading to environmental degradation. In addition, when the heaps are devoid of plant cover, they pose a threat to the environment and human health through dusting and thermal activity (Roztański, 1997).

An example of a site suitable for redevelopment is the area post-flotation[1] waste heaps of ZGH "Orzeł Biały" (Mining And Metallurgical Plant "Orzeł Biały") in Bytom are located.

The area in question is located at the eastern end of Bytom, at the border of the municipalities of Chorzów and Piekary Śląskie. It has an irregular shape enclosing an area of 70 hectares. There are three post-flotation waste heaps, which are the result of the last century's mining and processing of zinc and lead ores.

Figure 1 presents the satellite view of the area.

Figure 1. Bird's-eye view of the area to be redeveloped. 1. Heaps of solid excavation waste, 2. Active railway line no. 132, 3. national road 94, 4 national road 79, 5 Administrative border of Bytom and Chorzów, 6. „Żabie Doły" nature and landscape complex (own elaboration based on Geoportal Bytom, 2020).

[1] Flotation-technological process used in the treatment of zinc and lead ores. Using the phenomenon of different absorbability of certain substances, it consists in separating ground solids from each other. Some of the process components end up as waste at flotation dumps (Greszta, and Morawski, 1972).

The following are approximate boundaries of the designated area:

- from the east and southeast, it is adjacent to the "Żabie Doły" nature and landscape complex, created in the place of flooding of the hollows created by mining activity,
- the south-western border corresponds to the course of the railway embankment of a non-existent rail track. The embankment serves as a walking route, by which one can access on foot or by bicycle from the Arki Bożka housing estate in Bytom to "Żabie Doły",
- the western border is created by a section of national road 79,
- the south-eastern border leads through a narrow strip between the easternmost heap and the water reservoir,
- the eastern border corresponds to a fragment of the administrative border of Bytom and Chorzów Maciejkowice,
- the northern border outlines the complex of three heaps.

The heaps have the character of a plateau with relative heights ranging from several to several dozen metres. This form of heaps was created from settlers above ground level. The main component of the dumping ground is dolomite with an admixture of calcium (Greszta, and Morawski, 1972).

Below, Tables 1 to 25 show the preliminary assessment of the area in question in terms of its suitability for re-use. The analysis is based on selected parts of the post-industrial area assessment procedure proposed by M. Pierściński and B. Białecka (Pierściński, and Białecka, 2014).

Table 1.
Proper name and brief description of the area

Post-flotation waste heaps located near the "Żabie Doły" nature and landscape complex in Bytom

Table 2.
Code and location

Area code	Place:	Municipality:	Poviat:	Post code:	Street, no.:
-	**Bytom**	**Bytom**	**Bytom**	**41-902**	**Between Al. Jana Pawła II (national road 79) and Siemianowicka street (national road 94)**

Table 3.
GPS coordinates - outermost points

N 50° 20' 29.15" N 18° 56' 24.93" E	**E 50° 20' 16.71" N 18° 57' 35.69" E**	**S 50° 20' 5.11" N 18° 56' 51.90" E**	**W 50° 20' 22.07" N 18° 56' 20.54" E**

Source: own study based on Bytom Geoportal.

Table 4.
Size of the area

70 ha

Table 5.
Post-industrial area registration plot numbers

190/4, 1676/20, 668/21, 669.21, 297/194, 300/194, 301/194, 458/194, 461/194, 463/194, 302/193, 303/193, 306/193, 307/193, 309/194, 312/194, 313/194, 316/194, 434/202, 435/202, 354/45, 354/6, 470/12, 470/12, 299/12, 202/3, 205/8, 742/205, 740/204, 739/205, 620/205, 738/201, 734/192

Source: own study based on Bytom Geoportal.

Table 6.
Information on whether the legal status of the area is regulated

Yes	No	No data

Table 7.
Requirement for immediate intervention

Yes	**No**

Table 8.
Supply of the area with utilities (networks in the area)

Type	**Yes**	**No**
Electricity		**X**
Drinking water		**X**
Industrial water		**X**
Sanitary sewage system		**X**
Combined sewage system		**X**
Storm water drainage		**X**
Gas		**X**
Central heating		**X**
Telecommunications network		**X**
Other (specify)	**Unidentified network**	

Source: own study based on Bytom Geoportal.

Table 9.
Presence of buildings

Built-up area	**Non-built-up area**	No data

Table 10.
General description of existing cubature facilities (names, cubic capacity, initial and current use, ownership)

Complete lack of buildings

Table 11.
Local road and railway infrastructure

Road or railway facilities	Road/railway line number	Distance from the area
Nearest existing provincial, poviat or municipal road	**DK 79** **DK 94**	**100 m from western border of the area** **200 m from northern border of the area**

Table 12.
Local industrial lines near the area

Type of infrastructure	Distance from the area
Sanitary collector	**100 m from the western border and 200 m from the northern border of the area**
Medium voltage power line	**Within the area**
Low-voltage power line	**100 m from the western border and 200 m from the northern border of the area**
Gas pipeline	**100 m from the western border and 200 m from the northern border of the area**

Source: own study based on Bytom Geoportal.

Table 13.
Local air pollution emitters

Emitter's vicinity	Yes	No
The area is adjacent to the sewage treatment plant – distance less than 500 m		**X**
The area is adjacent to a functioning point emitter of air pollution – distance less than 500 m		**X**
Sewage treatment plant within the area		**X**
Point emitter of air pollution within the area		**X**

Source: own study based on Bytom Geoportal.

Table 14.
General internal evaluation of the communication system

Type	General description (degree of development, technical condition)
Road network and car parks	**None**
Rail infrastructure	**Railway line runs through the area**
Other (footpaths, bicycle paths, horseback riding paths, lifts, etc.)	**None within this area. There are "wild" roads, marked out by quad drivers and off-road motorcyclists, as well as makeshift ground facilities created for own use by competitive cyclists. The southern border is a walking and cycling path created on the embankment of the dismantled railway track**

Table 15.
General types of current use of the area

	Yes	No
Production and services		**X**
Housing		**X**
Communication and transport		**X**
Recreation in the open air		**X**
Arranged greenery or nature conservation		**X**
Open waters		**X**
Agriculture		**X**
Unused area	**X**	

The area is directly adjacent to the valuable nature conservation area "Żabie Doły", and sporadically there are strollers, cyclists or people riding quads or off-road motorcycles.

Table 16.
A document specifying the directions of future use of the area

Local area development plan	**X**	Study of land management conditions and directions	

Table 17.
Activity that caused degradation

Energy sector		Machinery industry		Industrial waste depository	**X**	Opencast mining	
Metal industry		Constructio n industry		Municipal waste management		Underground ore mining	**X**
Chemical industry		Paper industry		Wastewater treatment		Aggregate extraction	
Coke industry		Textile industry		Cement factory		Sand extraction	
Iron industry		Wood industry		Transport business		Rock mining	
Metallurgy of non-ferrous metals	**X**	Food processing		Underground coal mining		Peat exploitation	

Table 18.
Presence of waste in the area

Types of waste	Present	Not present	No data
Metals	**X**		
Pesticides	**X**		
Other than hazardous	**X**		
Neutral	**X**		

The group of dumps contains about 6 million. tonnes of waste, including 174 thousand tons of zinc and 36,000 tons of lead. The concentration of impurities is as follows (Roztański, 1997):

- Zn 500 – 10000 [mg/kg of soil],
- Pb 117 – 967 [mg/kg of soil],
- Cd 25,3 – 99,7 [mg/kg of soil].

Areas with a high content of heavy metals are divided into three main groups: primary habitats, secondary habitats, and primary habitats recovered secondarily (Baker et al., 2010). In primary habitats, metals are naturally released from parent rocks. Secondary habitats are the effect of mining and metal ore processing. This group of habitats includes flushing, flotation and metallurgical dumps. Post-flotation and washing dumps contain waste generated during the process of ore refining, while metallurgical dumps are the effect of storage of waste generated during metallurgical processes. The third group consists of areas in the immediate vicinity of pollution emitters that emit dust containing heavy metals and gases into the atmosphere (SO_2, NO_x). It also pollutes watercourses with metals (Baker et al., 2010).

The post-flotation dump described belongs to the secondary habitat, created by conducting ore processing activities outside the place of their exploitation.

Table 19.
Additional relevant area information (e.g. occurrence of slopes above 15%, ponds, ditches, shallow underground voids, especially large parking areas or storage yards, garages, extensive bushes, wild animals, etc.).

In the discussed area there are three solid waste heaps resulting from past mining and metallurgical activities. There are significant differences in height between the different parts of the area. They range from a dozen to several dozen metres. The area is crossed by the embankment with the railway track of line no. 132 with an arch running from the south to the north-west. Periodically, during rains, a watercourse appears, running from the north-west to the south-east and falling into a disappearing water reservoir. The area is scarcely planted mainly with grasses. The depression, which used to be a water reservoir, is filled by the reed and self-seeded birch trees.

Solid waste dumps often become specialized flora habitats, which have no equivalent in the natural environment. Such communities, which are covered with soils with an excessive content of heavy metals is considered rare and disappearing in the European Union legal act the so-called "The Habitat Directive" (92/43/EEC) (Jędrzejczyk-Korycińska, and Roztański, 2015).

The "Orzeł Biały" dumps are not richly colonized by vegetation. The reason for this is the concentration of pollutants in the soil and soil flow, preventing vegetation from rooting. As a result of reclamation attempts, various grass species were introduced to the dumping ground, such as: common bumblebee, sheep's fescue, reed grass and others. Not much of this vegetation is covered in dumps. There are also thermophilous grasslands, dwarf birch from self-seeding and individual trees of different species – the effect of unsuccessful remediation (Roztański, and Kapa, 2001).

Swallows nest in the slope of the dumping ground.

Table 20.
Suggested preferences for development directions in the light of the origin of the area

Production sites	Service building sites	Residential buildings	Communication and transport sites	Sport and recreation in the open air	Greenery, nature
	X	X		X	X

Two directions of terrain development are considered:

1. Due to the location of the area in the vicinity of the natural and landscape complex, it is suggested to use it as a recreational area, after stabilizing the surface of dumping grounds by fertilizing the soil layer and strengthening by creating grasslands and stands.
2. Development towards creating service or residential buildings. This requires the complete elimination of dumps, testing the soil below the dumps to determine negative health effects and taking action to eliminate such impacts.

The amount of zinc and lead (2-9% Zn, 0.3-2.6% Pb) contained in the waste dumps qualifies these elements for recovery (Jędrzejczyk-Korycińska, and Roztański, 2015).

Table 21.
Possibility of multifunctional development (work-housing-rest) in the light of the origin of the area and its size (only areas over 20 ha)

Yes	No.

After considering the issues presented in Table 20.

Table 22.
Main groundwater reservoirs and intakes

Criterion	Yes/No
Presence of groundwater intake	**No**
Location in a protection zone of the groundwater intake	**No**
Location within main groundwater reservoirs	**No**

Table 23.
Road facilities of supra-local importance

Road facilities	Road no.	Distance
Nearest motorway or expressway	**DTŚ 902** **A1**	**7 km** **4 km**
Nearest national road	**DK 94**	**100 m**
Nearest motorway junction	**A1 and A4**	**26 km**

Source: own elaboration based on Google Maps.

Table 24.
Is the area within the zone defined as "Protection of environmental resources, strengthening the system of protected areas and multifunctional development of open areas – preferred economic functions?"

Yes	**No**

Table 25.
Other facilities related to transport of supra-local importance

Facility	Name	Distance
Road border crossing point	**Chałupki**	**92 km**

Source: own elaboration based on Google Maps.

4. Summary

The conducted analysis is considerably simplified. It rather contributes to wider area studies, which should include, among others, a number of specialised research on pollutants, hazardous substances, etc.

The nature of the analyzed area, its former functions and its current location in the vicinity of the recreational area predispose the area to be an extension of the recreational functions of the "Żabie Doły" complex. Such a function would, of course, involve certain transformations that would make the area safe in terms of its impact on human health. The area would then be provided with appropriate infrastructure such as bicycle and walking paths and greenery to

serve new functions. The area topography would allow to obtain a conveniently located area for competitive bicycle activities with some adjustment.

Solutions for the improvement of revitalization processes are continuously developing. Examples include clusters, cooperation networks, information, communication and monitoring platforms, surveys or environmental audits (Bondaruk, and Pilch, 2013; Tereny Poprzemysłowe i Zdegradowane…, 2020). Nevertheless, continuous updating and sharing of data to support the management of degraded areas is still an open issue.

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