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Short Communication

Paths of Environmental and Economic Reclamation: the Case of Post-Mining Brownfields

Robert Krzysztofik*, Jerzy Runge, Iwona Kantor-Pietraga

Department of Economic Geography, University of Silesia,
Będzińska 60, 41-200, Sosnowiec, Poland

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Abstract

The aim of the article is to indicate the main reclamation paths of the post-mining areas in environmental and economic aspects. The phenomena have been discussed with the example of the city of Sosnowiec, where these actions are of exemplary nature in reference to Poland.

The article presents two main paths of activity, including environmental and economic directions. The first is applied in the situation of a lack of possibilities to utilize the post-mining areas for economic or other social activities. It comprises the establishment of areas designed for the development of new industries, services, logistics, or housing areas.

The environmental path is connected with the change in the function of the space. Due to partial human interference or natural plant succession, new areas with significant nature and landscape value are being shaped. Both directions play equivalent roles in municipal politics.

Keywords: brownfields, post-mining areas, post-industrial areas, environmental degradation, land use

Introduction

Brownfields constitute one of the more important elements of geographical environment in the post-industrial cities. As a component of urban environment, brownfields interact with the remaining elements. In most cases the interaction is negative [3, 5-7] especially in the initial phase of their existence. Due to this fact, the major priority is another and the rational usage of the post-industrial and post-mining areas as new elements of spatial and environmental composition of the cities [2].

The problem of brownfields is particularly visible in the Silesian Voivodeship, which constitutes a traditional area of development and, later on, restructuring of coal-mining [11].

In some traditional coal-mining centers, such as Będzin, Czeladź, Dąbrowa Górnicza, Chorzów, Siemianowice Śląskie, and Świętochłowice, there are not any coal mines remaining. In other cities, coal-mining has been significantly reduced. In Bytom, only 1 out of 6 mines existing in 1988 is left. In the analogous period in Sosnowiec, 3 mines were closed down and in Katowice, 2.

Coal mining elimination leads to an increase in areas that are of a brownfield nature, and sometimes also blackfields, that are understood as extremely contaminated areas, including post-flotation reservoirs, dangerous and toxic waste landfill, impurity tanks, and soil contaminated with chemicals [9].

The process of reclamation of the degraded areas takes various forms. Generally, in the Katowice region, three major models for the new management of the post-mining areas may be observed:

- renaturalized areas (natural reclamation)
- green areas, with their accompanying holiday function (natural reclamation)
- investment areas for industry, logistics, services, and large format trade
- housing areas

*e-mail: robert_krzysztofik@interia.pl

Each of the above-mentioned types of urban space has different criteria that it has to meet as far as its reclamation is concerned [12]. For settlement and post-industrial areas, the requirements are as follows: stability of slopes, erosion inspection, geotechnical research for the location of building and infrastructure, progress prognosis for subsidence basins above the deep mines, and landfill areas excluded from heavy construction. The expected adaptations should, in fact, consist of the change of the slopes' inclination, performing drainage, and erecting potential fortifying constructions.

The expected elements for rest and recreation areas are: the preparation of revitalization areas of relevant size (over 10 ha), securing the stability of the slopes, and removing dangerous elements of post-mining infrastructure. In the case of garden plots serving a double function (that is recreation and gardening), it is crucial that the slopes are of little inclination (<5 degrees) and the soil-forming ground with little rock content (<15%), as well as easy water supply, non-toxicity and moderate pH.

The adaptations, on the other hand, should concentrate on the change in the lay of the land, slope mitigation, building potential fortifying constructions, and introducing greenery. In the case of garden plots, an additional element consists of regulating water relationships and supplementing the re-cultivated area with humus additions.

The last group consists of forest areas. The requirements and necessary adaptations in this case are respectively connected with: low fertility soil, slope inclination of up to 35 degrees, relevant size of the area, and soil quality adapted to the species composition of the introduced plants in the first case. As far as adaptation activities are concerned, attention is paid to good drainage, potential additions of nutrients, humus, introduction of pioneer plants, and the potential of slope mitigation [12].

A very important element consists of a complex evaluation of the potential threats posed by brownfields, which might be effective both in the natural environment as well as in the direct zone of human habitation. Here, an estimate connected with interdisciplinary studies on human ecology is expected, along with an estimate of threats based on ecotoxicological evaluation.

These undertakings, in reference to brownfields in Sosnowiec, were performed in relation to the whole city [13], as well as selected wastelands, e.g. the former sand mine Maczki-Bor [8].

Sosnowiec, located in the eastern part of the Katowice Conurbation, is a city where all three types of revitalization of post-mining areas are present [9]. The process of re-composition of urban space, including elements of the natural environment, began here as early as the beginning of the 20th century, with the closing down of old coal mines and mining establishments and opening new ones. This also included open-cast mining.

The model of functional changes in brownfields, indicated in the introduction, are of varied typology. This remark refers to the first three models, in particular. The first of them includes parks, forests, cemeteries, forestation in the proximity of holiday resorts, grassland and grassland-forest assemblage, and meadow-forest. From a different point of view, these are cultivated greenery or green areas created as a consequence of plant succession. Although in the first case, the former brownfields have clearly specified new functions and a type of space management, in the second case, they are referred to as wasteland or in other cases – meadow or forest areas and sometimes as, so-called, other areas. Generally, it should be noticed that in the places with dominating plant assemblage of 20 to 30 years and older, the areas are referred to as forests or areas with a mixed character of gathering. In the places where plant succession is shorter, they are called wasteland or other areas.

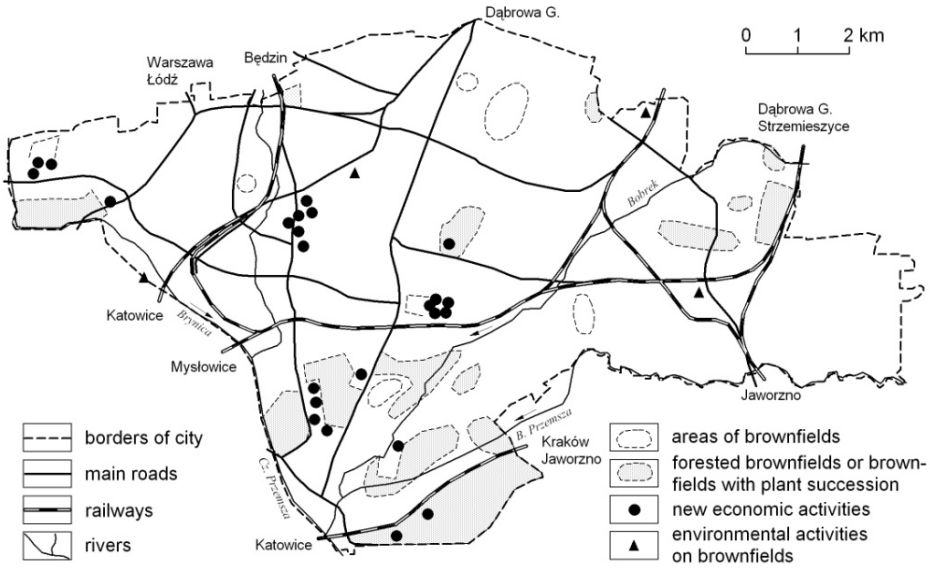

Fig. 1. City of Sosnowiec. Distribution of new environmental and economic activities on brownfields.
Source: By authors.

Table 1. Environmental typology of former brownfields as contemporary green areas. Examples from the city of Sosnowiec.

Element of environment	Part of city	Area	Former land use	Period of former land use
Plant succession				
Lasek Forest	Bobrek	115 ha	Coal mining, including open-cast mining	19th-mid-20th century
Grassland assemblage Bergi	Niwka-Dębowa Góra	24 ha	Heaps, mining shafts	19th-mid-20th century
Cultivated greenery				
Niwka Park	Dańdówka and Niwka	22 ha	Coal mining, including open-cast mining	19th-mid-20th century
Cemetery (municipal)	Niwka-Pawiak	14 ha	Mines, heaps	19th-mid-20th century
Recreation area Balaton	Maczki-Juliusz	32 ha	Sand and clay open-cast mines	First half of the 20th century

Source: By authors.

Former Brownfields as Contemporary Green Areas

The research of the authors states that in the territory of Sosnowiec, green areas created on brownfields cover an area of approximately 400 ha, with only about 10% of it being cultivated greenery. Their participation is the biggest in the eastern and southern districts. Examples of green areas created both as a consequence of the natural succession of plants, and as a result of secondary human activities, are presented in Table 1 and Fig. 1.

In forest assemblages, the dominating deciduous trees are: silver birch (*Betula lenta* L.), Norway maple (*Acer platanoides*), Pedunculate oak (*Quercus robur*) and European beech (*Fagus sylvatica*). Among the conifers, Scots pine (*Pinus silvestris*) and Black locust (*Robinia pseudoacacia*). The deciduous assemblages cover from 40% (Jęzor) to over 95% (northern Niwka), depending on the forest complexes. The deciduous assemblages are mainly connected with the areas of former coal-mining or waste storage related to it. The coniferous assemblages mostly cover the areas of the former sand open-cast mines.

Secondary phytocenoses (meadow, forest, forest-meadow), which developed in post-industrial areas, plays an important part both in introductory reclamation, as well as in final reclamation. This remark refers to the areas that were formed as an effect of plant succession, and also to conscious human activity. The role of these phytocenoses consists in limiting pollen-formation, as well as stabilizing the ground. Due to the fact that these assemblages have been developing for at least 5-7 years, pollen dusting is not presently observed (with the exception of extremely windy weather).

In the system of geographical environment components of green areas, water areas play an important part. They are mostly lake bowls created as a result of the surface exploitation of sand, clay or coal. They are of artificial nature, even though the long-lasting plant succession of the shore line added "natural" features to them. The biggest reservoirs are: Balaton, Stawiki, and Leśna [10]. Relatively few lakes have been formed as a consequence of ground level lowering. The largest ones can be found on the border of Zagórze and Kazimierz Górniczy districts. In this area, which in 2005 came under protection as the complex ecological ground use "Podmokłe łąki i zapadliska w Zagórzu," there is a domination of water-meadows, agrocenoses with wild fruit trees, forest areas of the fresh forest type (*Betula lenta* L., *Alnus glutinosa*, *Quercus robur*, *Populus nigra*, *Picea abies Acrocona*) and stenothermal grassland with thrift seapink (*Armeria elongata*). Many smaller ones seasonally go dry or transform into marshy areas.

Former Brownfields as Areas for New Industries Plant

Green areas constitute an important link in the urban ecosystem. However, in the urban development policies, their role is clearly secondary. The main assumption, though, is the re-usage of the post-industrial and post-mining areas for economic activity. The policies are supported by the institution of the Katowice Special Economic Zone. Within the borders of the city, in the last 15 years, 27 large-format buildings have been created, including 21 on post-mining areas (Table 2). A few new ones are being completed, mainly in the proximity of the former KWK Sosnowiec.

In the process of revitalization of land and post-mining establishments, as well as the urban space arrangement, with the participation of economic investments, Sosnowiec is a leader in Poland, and possibly also in Eastern Europe. At present, approximately 6,000 people are employed in all new establishments located within the post-mining area. An important issue in the revitalization process was the utilization of wasteland with low natural value, dating back in genesis to the first half of the 20th century, in the investment process. Those were mainly grass and bush assemblages. The participation of investments established on the areas of secondary forestation is insignificant, comprising only 2% of all new investment areas and their surroundings. An investor who cuts down the forest is obliged to plant trees in another area indicated by municipal authorities (such actions were performed, for example, in the process of erecting the current Real Shopping Center, previously Geant).

Table 2. Economic activity on post-mining areas in Sosnowiec.

Name of enterprise	Type of economic activity	Function of enterprise	Type of land use or economic institution before
Bitron	White goods industry	Brownfields	Coal mining (before 1945)
Caterpillar	Automotive	Brownfields	Coal mining (before 1945)
Cebi	Electronics industry	Brownfields	Coal mining (before 1945)
The Jehovah's Witnesses Convention Center	Religious functions	Brownfields, Greyfields	"Transgór," Coal mining (before 1945)
Duda-Silesia	Meat-industry	Brownfields	Coal mine "Saturn"
Ergom Poland	Manufacture of metal products	Brownfields	Coal mining (before 1945)
Ergomoulds Poland	Manufacture of plastic products	Brownfields	Coal mining (before 1945)
Ferroli	Manufacture of metal products	Blackfields	Coal mine "Sosnowiec"
Gimplast	Manufacture of plastic products	Brownfields	Coal mine "Saturn"
Haerus Electronite	Electronics industry	Brownfields	Coal mine "Sosnowiec"
Hoermann	Manufacture of metal products	Brownfields	Coal mine "Saturn"
Magnetti Marelli Exhaust System	Automotive	Brownfields	Coal mining (before 1945)
Nadwozia-Partner	Automotive	Brownfields	Coal mining (before 1945)
Plejada	Shopping center	Brownfields	Former mine slag heap
Polskapresse	Printing, editorial office	Brownfields	Coal mine "Saturn"
Process Electronics	Electronics industry	Brownfields	Coal mining (before 1945)
Real	Shopping center	Brownfields	Sand pit
Saltzgitter Mannesmann	Wholesale	Brownfields	Sandpit "Maczki-Bór"
Segu Polska	Automotive	Brownfields	Coal mine "Sosnowiec"
Silesian Logistics Center	Logistics	Brownfields	Coal mining (before 1970)
Watt	Engineering industry	Brownfields	Coal mining (before 1945)

Source: Authors.

The idea of urban politics is to allocate the brownfields primarily to economic activities [15]. When impossible due to the specifics of the environment (e.g. post-mining marsh), the space is left as a plant succession area. This direction in natural reclamation was applied in eastern Zagórze, for example, where the post-mining areas with the primary purpose of industrial activity were finally used as green areas. This revitalization argument was additionally supported by the occurrence of rare plant species in this area.

Former Brownfields as Housing Areas

The least common model of utilizing the post-mining areas is their assignment for housing purposes. The process was more popular in the socialistic era and it referred to the areas of the partially reclaimed open-cast mining activity. After the year 2000, housing investments have been initiated in the areas that lost their mining functions at the end of the 20th century. The most interesting example is the housing estate called "Wrzosowe Ogrody" (Lilac Gardens), located on the area of the former Sosnowiec coal mine and in the proximity of the industrial and services zone of the Katowice Special Economic Zone (the Narutowicza Area). The accomplishment of the revitalization of the area was in its planning activities based on the international experiences gained in the RESCUE project [14]. The experiences of this project are still present and applied in the most optimal and varied character of the actions taken here.

Another example is the development of the housing estate in the area of Andersa Street. This investment is realized in the area of the former shallow mining of raw materials. While the Wrzosowe Ogrody estate comprises a complex of multifamily buildings, the development at Andersa Street constitutes a compilation of multifamily and single-family units (terraced houses).

Both investments set an important trend in the possibilities of utilization of the post-mining areas and brownfields in general. However, this element of functional conversion of the degraded areas is connected not only to urban politics, but also market processes and levels of lands rent.

Conclusion – the Sosnowiec Model of Post-Mining Brownfields Reclamation as an Example

A crucial influence of brownfields on the natural environment and the conditions of human life should constitute an element of still developed research. Brownfields have a negative influence – on human health, shaping the landscape, the perception of the space, and the social-economic condition of the city. A top priority is to reclaim them or change their function.

The example of the city of Sosnowiec, in Śląskie Voivodeship, presents determination in understanding these negative interactions and, through numerous actions and their diversification, points out the path for other municipalities and decision-makers in cities.

The city has adapted two paths of brownfield management – the environmental path and the economic path. Both are adjusted to the real possibilities of transformation for concrete degraded areas. The idea of activities is included in the thesis that in the places where it is impossible to recreate economic functions, the new spatial order was to be shaped through partial management (taking into account natural components) and partially through the succession of plants. A good example of such politics was to resign from the investment plan on the post-mining areas in eastern Zagórze and protect them, with the consideration of both environmental components and the landscape, in general (region of complex ecological ground use "Podmokle łąki I zapadliska w Zagórzu").

Another issue is the question of the possibilities of diversification of tree species introduced to forest and forest-meadow habitats in post-industrial areas. Due to its accommodation possibilities, the most expected species is the European Black Pine (*Pinus nigra*), which is found (rarely) as a self-sown plant in some pre-war and post-mining areas in Niwka.

Another element is the question of uniformity of actions in the urban space. All larger complexes of post-mining areas are subjects of interest. Each one has a plan and policies for new development. Due to that, the effect of harmony is achieved, and also cohesion and balance of development. Such actions are especially desired [1, 4, 16].

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