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REGENERATION OF POST-INDUSTRIAL FACILITIES IN THE LEGNICA-GŁOGÓW COPPER MINING DISTRICT ILLUSTRATED WITH AN EXAMPLE OF “OBORA” FILLING SAND MINE

1. Introduction

The history of copper mining in Lower Silesia dates back to the thirteenth century and involves the Miedzianka, Kowary, Chełmiec and Czarnów Mines. Major development occurs near the end of the nineteenth century. Before WWII the “Lena” Mine is established (1936). During the war, works are carried out aimed at commissioning the Mine “Lubichów” (1940–1944). These mines constituted an element of the so-called Old Copper Mining District. At the end of WWII, in 1944, mining activities stopped here and equipment was destroyed and the mines were filled with water [1]. After the war mining operations started in the sequence as follows: “Lena” and “Konrad” (1948), “Nowy Kościół” (since 1950) and “Lubichów” (since 1956). Parallel to the construction of mines, copper ore enrichment plants, first “Lena” and then “Konrad” entered into operation. In 1951 work on the construction of Copper Smelter “Legnica” (Huta Miedzi “Legnica”) commenced [2]. All of these entities created the so-called Old Copper Mining District. The beginning of the New Copper Mining District (Legnica-Głogów Copper Mining District — LGOM) is considered to consist of the discovery, in 1957, of rich copper ore deposits (sandstone–carbonate–shale) in the region of Lubin and Polkowice and establishment in 1960 Units of the National Mining Corporation “Lubin” Under Construction [Państwowe Zakłady Górnicze “Lubin” w budowie] [1, 2]. In 1961 the National Mining Corporation “Lubin” Under Construction, was changed into the Copper Mining and Smelting Conglomerate Under Construction [Kombinat Górniczo-Hutniczy Miedzi w budowie]. In 1968 the Conglomerate was expanded with the addition of “Lena” and “Konrad” Mines which were at the same time a bridge between the Old and New Copper Mining District.

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Today (on the basis of preserved, but unfortunately few, remnants of the former copper mining in the Old Copper Mining District) open air museums and educational themed walking paths have been created. In contrast, the New Copper Mining District, known otherwise as the Legnica-Głogów Copper Mining District is the only functioning copper industry centre in Poland, and at the same time the twelfth of producer refined copper in the world (2010) and the third biggest producer of silver (2010). It owes its position to the rich copper ore deposits and an annual level of mined material of about 30 million tonnes of ore and about 452 thousand tonnes of native copper in 2010 [2].

Currently, copper ores and accompanying materials (gold, silver) are extracted in three mines — “Lubin”, “Rudna” and “Polkowice-Sieroszowice”. In the “Polkowice-Sieroszowice” Mine, rich deposits of rock salt are also extracted, aside from copper. Electrolytic copper and silver are produced in the “Legnica” and “Głogów” mines from concentrates prepared earlier in the Ore Enrichment Facility [Zakład Wzbogacania Rud], while copper products in the form of wire rods and copper wires are produced in the “Cedynia” foundry.

In order to obtain material to fill in underground mine workings, the Filling Sand Mine “Obora” started operations in the 70s of the twentieth century. It is located in a village of the same name. The “Obora” Mine is a subordinate, in organisational terms, of the Hydrotechnical Department [Zakład Hydrotechniczny Oddział] of KGHM Polska Miedź S.A. which is responsible primarily for operations of the facility for neutralisation of waste from extraction Żelazny Most and reclamation or projects involving the use of decommissioned facilities within LGOM (among others, the Gilów reservoir and tailing dumps of the decommissioned Konrad mine).

The location of the sand mine in LGOM and its functional link with copper mining facilities requires a comprehensive approach to the problem of rehabilitation and target development. In the next part of the article, the authors present examples of revitalisation of mining facilities which can constitute some reference to the plans in this regard for the “Obora” facility.

2. Good practice in revitalisation of industrial regions

Rich mineral resources determine the establishment of industrial regions in various combinations of mining-metallurgy, mining and energy, and others. Examples are: the Ruhr Area (coal), the Lusatian Basin (lignite) or the Mansfelder Region (copper) in Germany, Cornwall and West Devon (ferrous metals) in England or the Nord-Pas de Calais Region (coal) in France.

Regions with an economy based on traditional industries, especially mining, which are based on finite deposits, sooner or later face the need to mitigate the environmental and social problems arising from the liquidation of industrial estates. In the above mentioned regions, the restructuring of mining and of industries strongly associated with it has already occurred, which raised the need for organised reclamation and revitalisation activities. Such actions, although spread over time, will have to be taken also in the case of the Copper District, so reading about revitalisation projects already carried out can be helpful in shaping the vision for the Copper District.

In addition to environmental and social measures (compensation for loss of jobs), it is typical for the process of revitalisation of European industrial regions that their implementation is based on multi-annual programmes, allowing for a comprehensive approach and harmony of functions. The establishment of a new image for the region and the search for new opportunities for economic development were also goals. This objective was accomplished mostly through the preservation of selected elements of industrial heritage and their adaptation to new functions, not just museums, but also cultural, sporting and economic facilities. The Ruhr area is an example of this as, thanks to well-organized processes of revitalisation, it has been converted into a region of culture and business, among others through projects such as Landschaftspark Duisburg Nord set up in a former foundry which now functions as a museum, cultural and sport centre, but is also a characteristic component of the landscape of the Ruhr Area (Fig. 1).



Fig. 1. Landschaftspark Duisburg Nord, Germany.
Source: <http://view.stern.de>

The Lusatian and Central German Basin were, in contrast, transformed through the process of revitalisation of lignite mines into the largest artificial lake district, with a variety of functions. The most characteristic of the Basin regeneration projects have been given the brand “see”, which is also a guarantee of quality (Fig. 2).

In Cornwall and western Devon the objectives were industrial heritage based tourism and innovation. The highest form of protection — an entry in the UNESCO List of World Cultural and Natural Heritage — was instituted in 10 post-mining areas. Undoubtedly the biggest success, expressed in the form of more than one million tourists each year, is the Eden Project — the characteristic bio-domes created in exploited china clay open pits (Fig. 3). Innovative solutions are also used in the Lusatian Basin — e.g. floating homes. Figure 4 shows a floating church which was put in place of the one removed due to mining operations.



Fig. 2. Lookout point over the Sornoer Channel, Germany.
Photo: A. Ostręga 2010



Fig. 3. Eden Project — botanical gardens in a former china clay mine, England.
Source: www.edenproject.com

The cease of industrial activity in industrial areas is, due to the scale of necessary reclamation and revitalisation work to be implemented, a task that requires considerable effort and financial resources. At the same time it gives an opportunity for using industrial facilities in interesting ways: excavations, heaps, and the characteristic technical infrastructure. The examples demonstrated here show that a well utilised industrial past of industrial areas gives them competitive advantages, not least because of the development of industrial and sentimental tourism. The diversity of industrial facilities in LGOM also creates an opportunity for interesting development of the area.

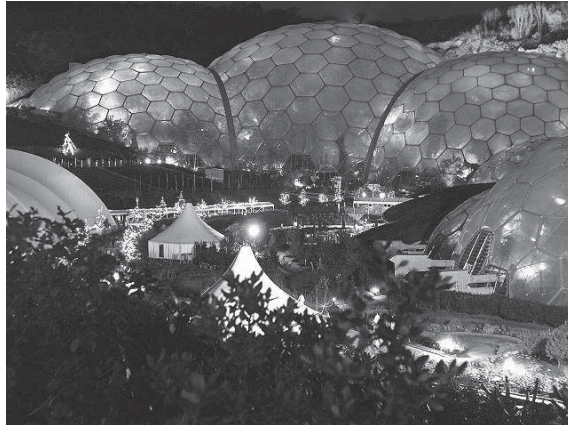


Fig. 4. Floating church on the Störmthaler See in a former lignite open pit, Germany. Source: LMBV

3. History, current status and prospect of operations for the Backfill Sand Mine “Obora”

Documenting the reserves of filling sand in “Obora” began in 1962. Subsequent documentations and additions to the documentation were performed over several decades and take into account additional exploration. The deposit consists of fine to medium grained sand, characterised by very variable lithology, complicated geological structure, glacial tectonics and variable thicknesses of up to 50 m. The deposit’s surface area is 246.2 ha, its thickness between 15.0 and 38.0 m, the overburden thickness ranges from 0.5 to 10 m and the depth of the floor from 15.5 to 48.0 m. Economic resources as of 31.12.2011 in cat. A + B + C1 + C2 are approximately 10.8 million m³.

The site of the current mine was originally a forested area with hills reaching an elevation of 190–200 m. The overburden has been completely removed during works aimed at gaining access to the deposit and was taken outside the deposit site. Since the mine is required to reclaim the site after operations and this is aimed at restoring the functions of the area, it has therefore been decided to select a forest-water direction as the closest to the original state, but also the most widespread and traditional for many open pit mines.

The extraction of the deposit through a wall and board system started on 01.09.1970. Resources that remain above the groundwater level are extracted through five levels and one level which is below that of the groundwater table.

Currently, the reservoir area is about 34 ha, and in subsequent years with the progress of mining works it will increase to 55 ha in 2015, 75 ha in 2020 and eventually 98 ha in 2025 (Fig. 5). At the sand mine site there is a single level dump in the north-western outskirts, and a two levels one in the area of the bank of the operational pool, which could, because of the geotechnical parameters, be a problem for the planned development of the post-mining area.



Fig. 5. “Obora” Sand Mine — present state.
Photo: KGHM Polska Miedź S.A.

The operating period for mining operations in the “Obora” mine is dictated by the existing mineral resources, and the demand of copper ore mines for filling material. The expected date of termination of operations is to be between 2022 and 2025 at the earliest. That date may be affected by the concept considered by KGHM of storage/backfill of excavations in copper ore mines using wastes from extractive industry.

The planned change in the concept of revitalisation from forest-water into recreational-therapeutic (described in the next point) will involve many formal and legal changes. Until these changes are made, reclamation works should be conducted in accordance with the documents accepted/approved. This situation unfortunately delays and hampers the rational and economic activities aimed at a new redevelopment of the post-mining site. During the remaining operational life of the mine, i.e. until the end of operations, reclamation works will be carried out with the formation of the target shape of the slopes and end banks after extraction of the above water elements. The aim will be to maximise the use of efficient mining equipment for earthworks in order to reduce the costs of rehabilitation. At the end of mining operations, earth and geotechnical works carried out at this time will be related to ongoing construction works and redevelopment of the facility for recreational, sport and therapeutic purposes.

4. The concept of land redevelopment for the exploited area of Filling Sand Mine “Obora”

A new concept takes into account the parallel extraction of sand and land reclamation and redevelopment of the post-mining site with a set III phase implementation schedule of activities, without disturbances to continuous operations of the mine (Fig. 6). The prepared “Land development study...” [3] assumes the conversion of the post-mining area into a recreational-therapeutic facility that is to provide relaxation and leisure for all age groups. Four areas of functionality have been foreseen:

- 1) Therapeutic leisure area — buildings with a therapeutic and leisure function with geothermal pools, external equipment such as swimming pool slides, Balneotherapy

Wellness Facility with devices for brine baths, inhalation treatments and rehabilitation of motor functions, an amphitheatre, graduation tower, catering facilities, a caravan centre, a reservoir for water leisure activities and water equipment rental.

- 2) Physical recreation facilities area — ski slope in winter, summer toboggan run with a gondola and T-bar lifts and infrastructure facilities, Bike Park, Skate Park, Dinosaur Park and a lookout point.
- 3) Sport-recreational area — recreational rowing track (8 lanes with a length of 1200 m), sports hall with a pitch for handball, basketball, volleyball, a full-size Olympic swimming pool, golf course, outdoor football pitch, tennis and basketball courts, along with bleachers.
- 4) Relaxation rest area — reservoir, fishing area, observation area – meadows, gastronomy, vacation cottages.

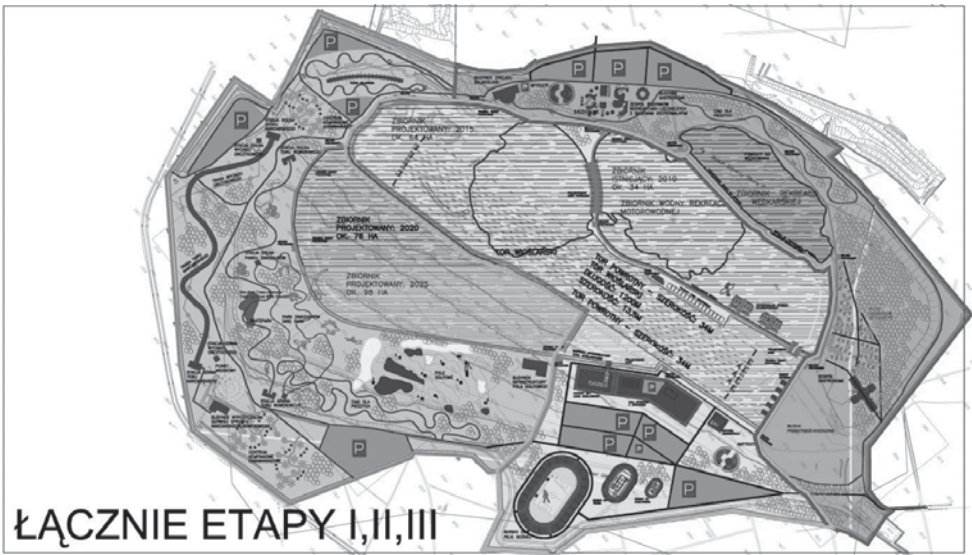


Fig. 6. Revitalisation concept of the “Obora” Filling Sand Mine.

Source: [3]

Not without consequence for the attractiveness of the described project are its surroundings in the form of copper ore mining and smelting areas. Conservation and adaptation of selected elements of the industrial heritage for various functions, including education, tourism and culture, will expand what the recreational and therapeutic centre, and thus increase the value of the entire project.

Discussion on the final shape of the facility, as well as specific solutions and purpose is carried out based on:

- consultations / surveys among employees of KGHM PM S.A.
- consultations with local authorities,

- consultations with local sports organisations,
- consultations with an extra-regional scope with various regional institutions, organisations or regional governments.

The scale of the planned project is significant for both the contractor and for the attractiveness of the region. Therefore, additional analyses have started to be conducted, which make it possible to ascertain the feasibility and maintenance of facilities at the operational stage. The scope for additional analyses will include:

- technical and environmental aspects, including the processes of eutrophication and maintaining the quality of water in the reservoir, the impact of surrounding industrial buildings on the condition of the water, stability analysis of the surface in the areas of building of structures and others,
- formal and legal, organisational and financial aspects — to determine the formula for the implementation of the investment,
- compliance with the characteristics of the terrain and surroundings,
- demand for certain services — market analysis, identification of similar services in the area, searching for niche functions with a supra-regional character.

5. Formal and legal aspects of implementation of the revitalisation project

From the point of view of the possibility of the implementation of the project involving reclamation and the target redevelopment of the “Obora” sand mine, a number of arrangements and the provisions of many documents must be arranged, such as:

- A Study on the preconditions and directions for the spatial development of the municipality,
- A local land use plan,
- The technical project of reclamation,
- Decision of the Starosta specifying the mode of reclamation,
- License,
- The deposit development plan,
- A mining plant operation plan.

The basis for the realisation of a particular mode of reclamation is the Starosta’s decision issued under the Act on the Protection of Agricultural and Forest Land [4]. The decision of the Lubin Starosta¹ for the filling sand mine was determined with a forest-water direction of rehabilitation and such was the one partially realised. Within the context of the planned investment, there is therefore a need to change the decision in such a way as to enable the implementation of recreational, sports and therapeutic, as well as educational

¹ Decision of the Lubin Starosta of 17 May 2007, no. GK.6018-III-3/1/07; Decision of the Lubin Starosta of 10 December 2007, no. GK.7437-11/07; Decision of the Lubin Starosta of 22 August 2008, no. GK.6018-III-3/3/08; Decision of the Lubin Starosta of 7 April 2009, no. GK.6018-III-3/7/09.

functions. The procedure for changing modes of reclamation will consist of the following activities:

- 1) Changes to the Lubią municipality planning documents: a Study on the preconditions and directions for the spatial development of the municipality and a local land use plan — in accordance with the procedure described in the Act on Land Use Planning and Space Management [5].
- 2) Introduction of changes to the technical project of the reclamation.
- 3) Submission of an application to the powiat's Starosta for a change to the mode of reclamation.
- 4) Introduction of changes to Mine documents: License, Deposit development plan, Mining plant operation plan, Mining plant operation plan for the mine to be closed .

This is a lengthy procedure which requires public consultations, obtaining opinions and arrangements from bodies determined by law.

Within the technical reclamation project, the operating schedule must be subjected to verification, allowing the gradual rehabilitation of land not required for mining activities, as well as the gradual introduction of investment associated with the target redevelopment. A change in mode of reclamation will also require consideration of the target redevelopment of the post-mining area of both the open pit and surrounding areas.

The concept for the target redevelopment of the "Obora" filling sand mine presented in the article implies the use of all of the assets of the future post-mining site, as well as the surroundings for new functions (water reservoir, geothermal resources and salt), which determines the size of the investment. From the legal point of view, it is the obligation of a mining entrepreneur to perform reclamation which as per the definition included in the Act on Protection of Agricultural and Forest Land [4] is limited to ensuring usability of transformed areas through technical, biological and chemical measures, if there is such a need. However, redevelopment is the responsibility of the legal successor in relation to the reclaimed land which is usually a municipality or private entity. In recent years, however, increased interest can be seen from mining companies in conducting further activities, other than mining, in post-mining areas. Depending on the scale of the undertaking, new functions can be implemented by a single entity such as the entrepreneur, or in different organisational formulas based on a division of tasks, risks, financial contributions and earnings.

The size of the project, which is reflected in its cost, leads to the development of formal and legal as well as organisational models of project realisation during the reclamation, redevelopment and operation of facilities. The construction of models should be based on:

- law in force in Poland (e.g. the act on public-private partnership)
- case studies of similar projects,
- the possibility of obtaining external funding to enable the determination of financing.

6. Summary

The Legnica-Głogów Copper Mining District, and before that the Old Copper Mining District play an important role in the economic development of the region and in improving

the standard of living for its residents. At the outset little attention was paid to the adequate protection of industrial heritage, so many valuable facilities (the first, the oldest, with unique architecture, etc.) were subject to physical removal. Currently greater emphasis is put on the methods of rehabilitation and development of post-mining facilities.

The changes proposed in the article with respect to the reclamation and target redevelopment of the “Obora” filling sand mine require updates to be made to multiple documents, however, this gives an opportunity to create an attractive recreational-therapeutic offer based on natural resources like brine and geothermal waters. Selected industrial facilities, both the oldest preserved (in the so-called Old Copper Mining District) and those that are still in operation (in LGOM) provide an opportunity for the enrichment of the offer by touristic, educational and cultural aspects.

It is essential that in the process of revitalisation of the Copper Basin District what should be maintained is not only diversity, but also the harmony of functions. Conducted repair processes should be a revitalisation – a process of bringing back life, not only within an environmental understanding, but also socio-economic, and they also should obtain adequate visibility and recognition, as in the case of European industrial areas described in the article.

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