

DEVELOPMENT OF E-SERVICES IN THE PROCESS OF POST-MINING AND POST-INDUSTRIAL AREA MANAGEMENT IN THE SILESIA REGION

Adam HAMERLA

Central Mining Institute, Katowice; ahamerla@gig.eu, ORCID: 0000-0002-9105-6856

Purpose: the main purpose of this paper is to present the idea of a new e-service concerning post-mining areas, which is being developed in the Silesian Voivodeship and which is expected to increase their attractiveness.

Design/methodology/approach: The new e-service is based on the development of a system for the inventory and valorisation of post-mining areas. In the course of the work, a field inventory of the areas is carried out, which involves collecting information on their location, configuration in relation to main transport routes, surface configuration and the manner of their management. These data are collected in a database system, which is additionally linked with algorithms enabling benchmarking, assessment of ecosystem services and evaluation of investment attractiveness. All of this will create a new e-service that will enable decisions to be made regarding their further use by various stakeholders.

Findings: The value of post-mining and post-industrial areas in the processes of economic transformation of the Silesian Voivodeship and the needs of stakeholders for information regarding these areas.

Research limitations/implications: The results provide a basis to improve the effectiveness of regional development planning, especially solutions for SME involvement and cooperation. The results confirm, that a detailed study of entrepreneurs' needs should be included as the main instrument for the implementation and for gaining reliable information on the effectiveness of implemented solutions in the field of innovation support.

Practical implications: The Silesia Voivodeship has a large number of post-industrial areas, for which the state and degree of degradation is often undefined. Building new e-services for a region in transition is an important factor for its competitiveness. The OPI-TPP 2.0 service allows the valorisation of sites and additionally provides information to potential investors on the necessary planning, investment and environmental measures.

Originality/value: The contribution of the research to the development e-services in post-mining land management.

Keywords: e-service, post-mining, post-industrial area, OPI-TPP 2.0.

Category of the paper: review paper.

1. Introduction

Economic and social transitions related to the process of fair transformation have led to an increased awareness and need for requirements concerning post-industrial and post-mining areas. The problems of deindustrialisation: structural unemployment, decapitalised technical infrastructure, recession of enterprises and liquidation of entire industrial centres, most frequently concern post-industrial zones located in highly urbanised areas and trigger crisis situations in the spatial, economic, social and environmental spheres. In the majority of European countries, measures have been implemented for years with the aim of restoring brownfield sites to local communities. Their revitalisation is related to transformation of these areas into modern economic, residential, cultural or leisure space. Actions aimed at the spatial and functional transformation of post-industrial sites were already undertaken in Western Europe in the 1970s and 1980s. In case of Central European countries, projects to revitalise post-industrial sites have been carried out since the 1990s, and in recent years they have become one of the most important factors in the development and reimagination of cities (Domański, 2009).

The Silesian Voivodeship features the largest area of post-industrial and post-mining land in the country, which until now has not been perceived as attractive for creating new locations. Their number and area will be constantly increasing in relation to the fair transformation process. Those areas usually cause space degradation, which has a negative effect on the image of the region and its competitive position. Revitalisation of post-industrial sites, which also includes post-mining areas, is an opportunity to reimagine them, i.e. giving them new social and economic functions, improving their aesthetics and the quality of life. Revitalisation of these post-industrial sites plays an important role not only in Poland but also in Europe, as it helps to avoid the growth of urban sprawl and to improve the quality of the urban environment. Revitalisation thus fosters the conditions necessary for sustainable development (Każmierczak, 2014). Revitalisation of post-industrial sites requires an efficient and effective management process, with development planning of these sites as a crucial element for success. Such planning should be preceded by identification of the sites in question and their valorisation, including an assessment of the development potential of a given site.

The aim of the article is to present a solution developed in the Silesian Voivodeship for conducting the process of identification and valorisation of post-industrial and post-mining areas in the form of a new e-service.

2. The impact of transformation on post-industrial sites in the Silesian Voivodeship

The development of the Silesian Voivodeship has been strongly influenced by traditional industries, mainly hard coal mining and metallurgy. Restructuring processes of hard coal mining and metallurgy initiated a period of very significant transformations in the economic sphere of individual cities of the Silesian Voivodeship, which are currently being continued as a process of just transformation (WWF, 2021). Liquidation processes in hard coal mining are the effect of that. The concentration of industry on such a small area has contributed to a significant transformation of the natural environment, resulting in the creation of extensive industrial heaps, pits and sinkholes. Saline mine waters discharged into surface waters are also a threat to the environment. Virtually every town in the Upper Silesian Coal Basin has within its borders areas directly or indirectly related to mining activities which require a process of revitalisation and reconversion towards new economic activities or provision of ecosystem services (CEC, 1990). There is a lack of a complete, systematized and publicly available valorisation of brownfield sites, including information on their value for the economic sector, the identification of which could make a real difference and increase the pace at which they could be returned to economic use. Dispersed information, also held by private entities, is a serious barrier to the redevelopment of these sites. From this perspective, full utilisation of the potential of post-industrial sites in Silesia will require the implementation of a long-term investment policy, sustainable space management, as well as an appropriate, data-driven system for the distribution of funds to restore their functions (Programme, 2008). Therefore, it is extremely important to take action and to provide appropriate tools which, equipped with data, will support the process of restoring post-industrial sites to economic circulation while preserving and strengthening their value in terms of infrastructure, space, environment and culture.

According to the data of the Ministry of Agriculture and Rural Development published in studies (CSO, 2019), there were 5269 ha of devastated and degraded land in the Silesian Voivodeship in 2018, which is about 0.43% of the area of the Voivodeship, and in 2020 this figure decreased slightly to about 0.40% (CSO, 2020). In the whole country this percentage is more than twice lower (Table 1).

In terms of the total area of land that requires rehabilitation, the Silesian Voivodeship is ranked 3rd in the country. That area has been growing at least since 2010, whereas a decrease can be observed at the more general, national level.

Table 1.

Devastated and degraded land requiring rehabilitation according to Polish Classification of Activities in 2006, 2018, 2019

Year	Total [ha]	Thereof as a result of the following activities				
		Mining and extraction of raw materials		Metal production [ha]	Energy, gas and water supply [ha]	Other [ha]
		Energy [ha]	Non-energy [ha]			
Poland						
2006	65143	12646	27347	179	999	23974
2018	61863	11369	29658	126	790	19920
2019	62089	12024	29976	123	939	19027
Silesia						
2006	4717	2251	1910	173	178	205
2018	5269	2865	1988	101	153	162
2019	4982	2313	2250	98	153	168

Source: (GUS, 2019).

Mining, especially hard coal mining, which is responsible for almost the entire increase in the area of land requiring reclamation, remains the main cause of land degradation and devastation in the region. Several percent of the degraded or devastated land area is reclaimed annually (Table 2). In 2016-2018, the amount of reclaimed land decreased more than twofold, when compared to 2005-2015, and the amount of land developed per year has generally been decreasing since at least 2000. The method of land reclamation does not always meet the needs of natural environment protection. In terms of the total area of recultivated land in 2018, the Silesian Voivodeship was in the 13th place in the country, and in terms of the area of developed land, in the 6th place. The rate of reclamation and development of degraded land increased to 207 ha/year in 2019 against 65 ha/year in 2018.

Table 2.

Devastated and degraded land requiring rehabilitation and rehabilitated land in Silesia Voivodeship

Item	2000	2005	2010	2015	2018	2019
Land requiring rehabilitation (at end of year)	5828	4602	4372	4889	5269	4982
Devastated	4842	43835	3668	3812	4182	3564
Degraded	989	767	704	1077	1087	1418
Land rehabilitated during the year, including:	298	114	89	108	39	168
For agricultural purposes	17	23	28	41	5	21
For forestry purposes	231	35	14	50	9	28
Developed land	255	55	39	27	26	39

Source: (GUS, 2019).

The region lacks detailed registers of brownfields and degraded areas, as well as an updated system collecting information on these sites, so the CSO data can only be treated as estimates. The lack of information on the actual size of brownfields, their activities, environmental threats related to their exploitation, their transport connections and other factors, causes significant difficulties in taking up planning activities and making sites available for investment purposes.

The process of assessment to reuse post-industrial objects and sites takes many conditions and factors into account, among which the most important are: location, as well as legal, social, environmental and economic conditions (Cheng, 2020). The redevelopment of a post-industrial site requires a plan based on a detailed diagnosis and valorisation of the area, which is then the basis for monitoring of the implemented actions, as well as for building a strategy for the development of the area and its promotion (Kobylańska, Gawor, 2017). It is worth noting that the problem with access to information on post-industrial sites does not only appear in the Silesian Voivodeship or Poland, but also occurs in other European countries, including those with a rich industrial history. In Belgium, for example, there is no reliable quantitative data on brownfield sites. Only in Wallonia has such an inventory been created, covering sites where economic activities had previously been carried out. The registered sites are classified according to their level of contamination, dividing them into contaminated, slightly contaminated or uncontaminated but in need of rehabilitation (Maes et al., 2007). The need for an inventory of brownfield sites is also indicated by studies conducted in other European countries where industry is still relatively active. For example, Balkan countries, such as Serbia, Bosnia and Herzegovina, report the need to create a database of degraded sites at national level, which would take into account geographical location, status and use of the sites (Ignjatić et al., 2017; Vujičić, Tijana, 2017). The need to provide public access to the data on these areas is also emphasised, as it is the first step in solving the problems of revitalisation of brownfield and degraded sites.

3. A concept of e-service dedicated to brownfield sites

Poland has no database on brownfields (including mining sites) and the need to introduce a unified form of the register of brownfields, which is also important to promote those sites to investors, has been called upon for many years. Attempts to collect data on brownfields were made in the first decade of the 21st century in the Małopolskie and Mazowieckie Voivodeships (Zagórska, 2013). The first significant database on brownfields and degraded areas, on a regional scale, was called the Information Platform on Brownfields and Degraded Areas (OPI-TPP) ([orisp.pl/...](http://orisp.pl/)), which was created as part of the Public Regional Spatial Information System of the Silesian Voivodeship. The digital service was created on the basis of the findings of the Regional Programme for Conversion of Brownfields and Degraded Areas (Programme, 2008). The service collected information on several hundred degraded and post-industrial sites and carried out a preliminary assessment in terms of the environmental risks associated with them and in terms of potential directions for their future development (Bondaruk, Zawartka, 2011). The platform was the first and, so far, the only, open regional system which collects data on post-industrial sites. However, despite its pioneering character, the problem with updating

the system and data as well as investments in the development of its functionality remains unresolved. In addition, the first attempts of the OPI-TPP platform to valorise brownfield sites, based mainly on environmental threats, have not evolved as needed, especially towards an assessment in terms of the specific needs reported by investors, while there are yet unused economic, cultural or natural resources available on brownfield sites. Determination of the value of brownfield sites for particular directions of use should therefore be the basis for decisions on how to manage them (Gasidło, 2013).

In 2020, the Marshal's Office of the Silesian Voivodeship in partnership with the Central Mining Institute launched a project entitled "Expansion of the system for management of post-mining areas in the Silesian Voivodeship" (opi-tpp2.pl). An e-service called OPI-TPP 2.0, dedicated to mining areas as a particularly characteristic group of post-industrial sites for the Silesian Voivodeship, is to be its outcome. The new OPI-TPP 2.0 system is in a way the successor of the first database of post-industrial sites in the region, which was called OPI-TPP. However, in contrast to the first database, the new e-service has different conceptual assumptions and functionalities both in terms of the collected data and the presented content. The main advantage of the new e-service will be the development of functionalities related to the provision of information to users, including solutions implemented in the system that enable profiling of assessment of brownfield potential. A simplified structure of the OPI-TPP 2.0 e-service is shown in Figure 1.

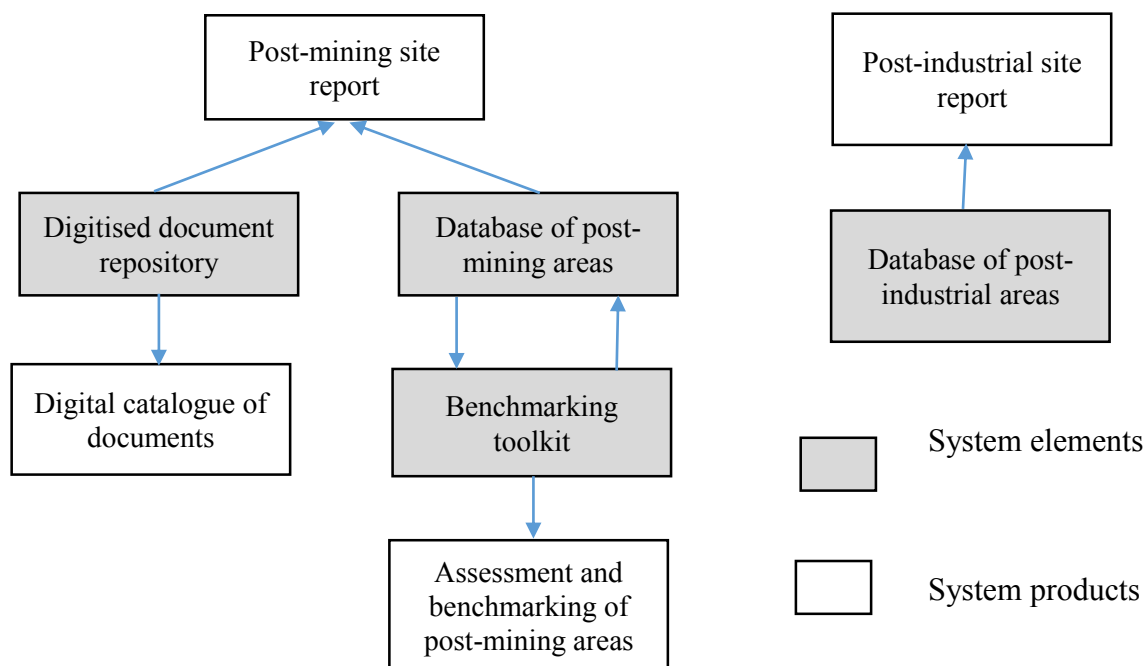


Figure 1. OPI-TPP 2.0 structure

The OPI-TPP 2.0 system will make available a wide range of data on brownfield sites, the most important of which will concern:

- Previous activities.
- Address (town/city, street, number, code).

- Covered area.
- Parcel numbers.
- Zoning in local development plan.
- Ownership structure.
- Land cover structure.
- General condition of the area.
- Internal transport system.
- Possibility of access by truck/cars.
- Distance from an exit from a highway or other national road.
- Access to infrastructure networks.
- Types of activity conducted.
- Cubature objects.
- Vegetation structure.
- Waste in the area.
- Environmental hazards.

The scope of the data was established on the basis of a literature study and expert interviews, and was then verified by stakeholders, especially investors, who will undertake activities to redevelop the sites included in the database.

4. Features of the OPI-TPP 2.0 e-service

E-service is identified and understood as a service that meets the following criteria (Dabrowska et al., 2009):

- it is provided in a partially or fully automated manner and based on information technology,
- it is provided on and via the Internet,
- it is customised with respect to the recipient (personalised),
- the parties to the service are located in different places (a remote service).

The development of e-services is a natural consequence of the progress in ICT technologies and business models in both economic and public spheres. OPI-TPP 2.0, as a modern e-service, is an answer to important challenges of the Silesian Voivodeship in relation to the process of fair transformation in the economic and environmental spheres. The data collected and processed with use of the OPI-TPP 2.0 system will make it possible to analyse and assess the possibility to restore post-mining areas to economic life and to enable revitalisation and investment processes associated with them. The main solutions implemented in the new e-service include:

- The analytical module: the service will provide access to four dedicated analytical tools that will allow for initial valorisation of brownfield sites and for comparison of results obtained from different sites.
 - Analysis of the investment attractiveness of a given area will take into account both indicators directly connected with the area, such as its transport connections level, business environment, access to utilities as well as socio-economic conditions of the county in which the area is located.
 - Analysis of the degree of preparation of the site for redevelopment, including information on the advancement of rehabilitation works after previous activities had been stopped. This analysis should provide the potential user of the site (investor) with an estimate of the time and potential costs that will have to be incurred before a new investment can be properly executed or the site can be made available for new functionalities. Both the time and the planned costs are associated with the activities that are to bring the site back into the socio-economic cycle.
 - Analysis of the potential to provide ecosystem services¹ is a tool to indicate whether the re-use of all or part of an area for economic purposes is justified in terms of cost, locational or social aspects. The results of the analysis will be supplemented with information related to the scarcity of supply of specific ecosystem services in the area.
 - A brownfield benchmarking mechanism is a tool in which the user, by selecting data sets and/or indicators, will be able to make comparisons between sites. This tool is intended to help the user to select and choose the most suitable site for their planned investment.

The original nature, dedicated methodology and provision for choices of weighting factors in the analytical process as required by the user is central to all analytical tools.

- The digital repository will be a collection of digitised documents related to mining areas, which have not been published in the digital form so far. The repository is to serve as a digital archive of documents related to historical mining activities carried out in the areas described in the database. The repository will contain materials collected during the construction of the system such as photographs, orthophotomaps, cartographic studies, numerical terrain models and, in selected cases, 3D visualisations. All information collected in the repository will be catalogued and linked to the database on post-industrial sites. An example of one of the visualisations developed for the purposes of the repository is presented in Figure 2.

¹ Ecosystem services are the states and processes through which natural ecosystems, including the living organisms they contain, sustain and fulfil human life processes. They are responsible for maintenance of biodiversity and production of ecosystem goods, such as seafood, food, timber, biofuels, cellulose, substances of pharmaceutical value or (pre)industrial products. In addition to the production of goods, ecosystem services include functions that sustain life processes, such as waste absorption and processing, regeneration processes, and provide many non-tangible (aesthetic and cultural) benefits to humans (Daily, 1997).

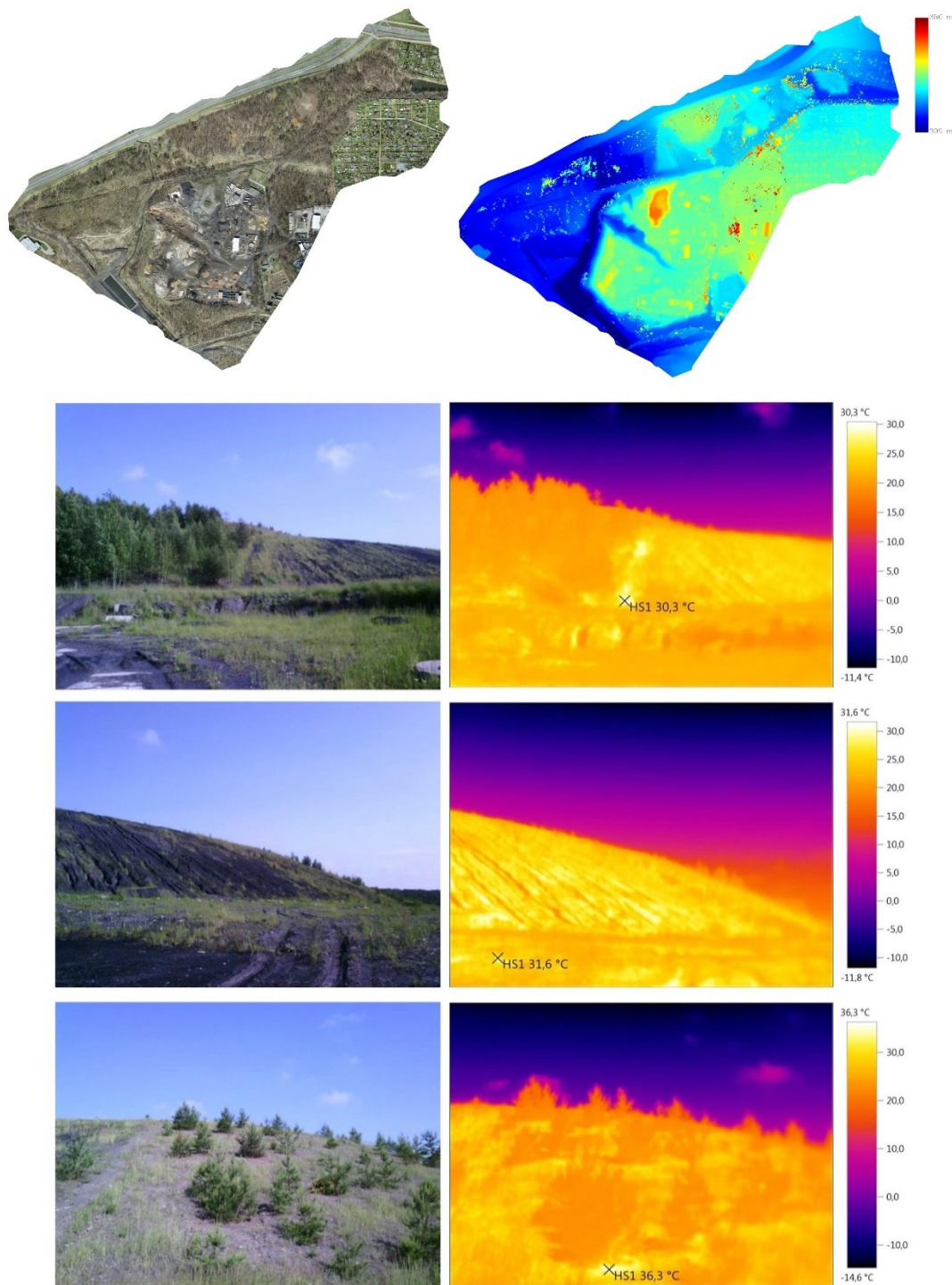


Figure 2. Example visualisations of OPI-TPP 2.0 system

- The method of visualization is an important element of the e-service: on the one hand it should meet the standards expected for this type of service, on the other hand it should be user-friendly. Therefore, the new system will be prepared in the form of a tool based on commercial market solutions which specialise in highlighting the advantages of the presented products and services. Bilingual, responsive design of the system without the need for registration is only one example of what will be implemented in the new e-service.

- The update mechanism is one of the most important elements that distinguishes OPI-TPP 2.0 from the previous solution. The data available in the system will be updated along with the acquisition of information on new areas and statistical data necessary for calculations performed with use of algorithms. In this way, the e-service is to provide current information on mining areas in the region.

5. Summary

Fair transformation in the Silesian Voivodeship brings a number of social, economic and environmental challenges. In the context of the changes brought about by the transformation, the issues related to space and the emerging large number of post-industrial, especially mining areas, are of particular importance. Unregulated legal status, assets located on these sites and, frequently, land contamination are only a few examples of the hindrances against their further economic use. On the other hand, these areas are often perfectly well-connected in terms of transportation and have significant economic potential due to their location. Their infrastructure can often be used for various economic activities. In addition, these areas also carry environmental and social potential and can be a space for the development of ecosystem services, with reparatory and even housing potential. Unfortunately, both the potential and the barriers to the use of these areas are largely unknown, which means that they do not attract significant interest from investors and are a major burden for local authorities and the society. There are no central databases on post-industrial and degraded areas in Poland. At the regional level, inventories of these sites are usually random and incomplete. Nevertheless, the residual existing online databases on brownfield sites make it possible to present sites designated for redevelopment and show the scale of "unused resources" held by municipalities or counties. However, post-industrial sites are a valuable resource of development space for cities, and their inventory and valorisation is the first stage in their management, in accordance with the principles of sustainable development (Huculak 2010). The emerging e-service OPI-TPP 2.0 in the Silesia Voivodeship is an opportunity for the region, which will undergo a strong transformation in the coming years. The information provided by the service will enable more effective use of post-industrial sites and, in the long run, it will allow for mitigation of the social, economic and environmental effects of the transformation.

Acknowledgments

Presented results have been developed as part of the project „Development of a system for management of post-mining areas in the Silesian Voivodeship” (OPI-TTP 2.0) is implemented by the Central Mining Institute in partnership with the Silesian Voivodeship. Funding for the project was granted from the European Regional Development Fund under the Regional Operational Programme of the Silesian Voivodeship for 2014-2020, Measure 2.1 Support for the development of digital public services.

References

1. Bondaruk, J., Zawartka, P. (2011). *Ogólnodostępna platforma informacji "Tereny przemysłowe i zdegradowane" (OPI-TTP) – nowoczesne narzędzie systemowego zarządzania informacją o terenach przemysłowych w województwie śląskim*. Prace Naukowe GIG. Górnictwo i Środowisko, Główny Instytut Górnictwa, 31-49.
2. CEC (Commission of the European Communities) (1990). *Green Paper on the Urban Environment*, COM(90) 218. Brussels.
3. Cheng, J. (2020). Data Analysis of the Factors Influencing the Industrial Land Leasing in Shanghai Based on Mathematical Models. *Mathematical Problems in Engineering*, vol. 2020, Article ID 9346863, <https://doi.org/10.1155/2020/9346863>.
4. Daily, G. (1997). *Nature's Services: Societal Dependence on Natural Ecosystems*. Washington, D.C.: Island Press.
5. Dąbrowska, A., Janoś-Kreso, M., Wódkowski, A. (2009). *E-usługi a społeczeństwo informacyjne*. Warszawa: Difin.
6. Dempwolf, C. (2010). *An evaluation of recent industrial land use studies: do theory and history make better practice?* http://www.academia.edu/319809/An_Evaluation_of_Recent_Industrial_Land_Use_Studies_Do_Theory_and_History_Matter_In_Practice.
7. Domański, B. (2009). Rewitalizacja terenów przemysłowych – specyfika wyzwań i instrumentów. In: W. Jarczewski (ed.), *Rewitalizacja miast polskich, t. 4: Przestrzenne aspekty rewitalizacji śródmieścia, blokowiska, tereny przemysłowe, pokolejowe i powojkowe*. Kraków: Instytut Rozwoju Miast.
8. Gasidło, K. (2013). Przekształcenia terenów i obiektów przemysłowych jako problem urbanistyczno-architektoniczny województwa śląskiego. *Zeszyty Naukowe. Architektura*, z. 52. Gliwice: Politechnika Śląska, pp. 65-80.
9. GUS (2019). *Ochrona Środowiska*. Warszawa: Urząd Statystyczny.

10. Huculak, M. (2010). Rewitalizacja terenów przemysłowych. Polskie doświadczenia i perspektywy. In: W. Jarczewski (ed.), *Przestrzenne aspekty rewitalizacji śródmieścia, blokowiska, tereny przemysłowe, pokolejowe i powojkowe. Rewitalizacja miast polskich, tom 4*. Kraków: Instytut Rozwoju Miast.
11. Ignjatić, J., Bojana, N., Rikalović, A. (2017). *Trends and Challenges in Brownfield Revitalization: A Gis Based Approach*. Proceedings of the XVII International Scientific Conference on Industrial Systems (IS'17), Novi Sad, Serbia.
12. Kaźmierczak, J. (2014). Rewitalizacja terenów przemysłowych a kształtowanie przestrzeni publicznej w centrum miasta na przykładzie projektu Lyon Confluence. In: A. Maciejewska (ed.), *Współczesne uwarunkowania gospodarowania przestrzenią – szanse i zagrożenia dla zrównoważonego rozwoju, organizacja gospodarowania przestrzenią*. Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej.
13. Kobyłańska, M., Gawor, Ł. (2017). Problematyka przeobrażeń przestrzennych w procesach rewitalizacji terenów przemysłowych. *Studies of the Industrial Geography Commission of the Polish Geographical Society*, 31(1), 68-80.
14. Maes, E., Schadeck, S., Brahy, V. (2007). *La contamination locale des sols. Rapport analytique sur l'état de l'environnement wallon 2006-2007*, MRW-DGRNE, Namur 736.
15. Program (2008). *Wojewódzki Program Przekształceń Terenów Przemysłowych i Zdegradowanych*. Katowice: Instytut Ekologii Terenów Uprzemysłowionych & Główny Instytut Górnictwa.
16. Vujičić, T. et al. (2017). *Browninfo Methodology and Software for Development of Interactive Brownfield Databases*. International Symposium on Innovative and Interdisciplinary Applications of Advanced Technologies. Cham: Springer.
17. Wojnarowska, A. (2011). *Rewitalizacja zdegradowanych obszarów miejskich, przykłady praktyczne*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego.
18. WWF (World Wide Fund For Nature) (2021). *Boosting Employment, Environment, Economy Through 'Just Transition'*, https://wwfeu.awsassets.panda.org/downloads/eu_coal_regions___boosting_employment__economy__environment_through__just_transition_.pdf.
19. Zagórska, E. (2013). Wojewódzkie bazy danych o terenach przemysłowych i zdegradowanych jako przykład podejmowanych działań w dziedzinie rewitalizacji terenów przemysłowych i zdegradowanych. *Studia Ekonomiczne*, 155, 108-121.