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INNER-CITY BROWNFIELDS – GENESIS, SPECIFICS OF CONTAMINATION, POSSIBILITY OF RENEWAL

ŚRÓDMIEJSKIE TERENY POPRZEMYSŁOWE – GENEZA, SPECYFIKA ZANIECZYSZCZENIA, MOŻLIWOŚCI ODNOWY

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Streszczenie. Śródmiejskie tereny poprzemysłowe stanowią rezerwar atrakcyjnej przestrzeni miejskiej, która może być ponownie wykorzystana na potrzeby przemysłowe lub zagospodarowana w inny sposób. O dużej dostępności terenów poprzemysłowych w miastach zdecydowała transformacja gospodarcza epoki postindustrialnej, podczas której śródmiejska lokalizacja produkcji okazała się zbyt kosztowna, a posiadane zasoby przestrzenne okazały się niedopasowane do potrzeb skoncentrowanych, zautomatyzowanych i sfragmentaryzowanych nowoczesnych procesów produkcyjnych. Wcześniejszy industrialny model rozwoju podporządkował rozwój przestrzenny miast potrzebom przemysłu, zagarniając duże i atrakcyjnie położone przestrzenie na swoje potrzeby. Odnowa tych terenów jest szansą na ich efektywne wykorzystanie. Barięram w tym procesie jest, między innymi, zanieczyszczenie gleby i ziemi – słabo rozpoznane, bardzo różnicowane i kosztowne w likwidacji. Zanieczyszczenie gleby i ziemi na terenach poprzemysłowych jest trwałym zapisem wieloletniej presji przemysłowej znacznie silniejszej i jednocześnie zdecydowanie słabiej rozpoznanej niż stan środowiska ich otoczenia. Zanieczyszczeniu gleby i ziemi terenów byłych zakładów przemysłowych często towarzyszą pozostawiona infrastruktura (lub pozostałości po niej), a także odpady zgromadzone w obiektach przemysłowych i na powierzchni ziemi. Taka specyfika śródmiejskich terenów przemysłowych bardzo ogranicza możliwości ich transformacji. Nowe regulacje prawne, wprowadzające status historycznego zanieczyszczenia gleby i ziemi oraz planu remediacji, stanowią istotny bodziec do intensyfikacji korzystnych procesów przemian śródmiejskich terenów przemysłowych poprzez ich sanację ekologiczną i mogą być skuteczną drogą prowadzącą do zrównoważonego rozwoju miast.

Key words: post-industrial areas, brownfields, soil contamination, remediation plan.

Słowa kluczowe: śródmiejskie tereny poprzemysłowe, zanieczyszczenie gleby i ziemi, remediacja.

INTRODUCTION

Industrial plants, fixed in a particular time and place, are interconnected with their natural, social, economic, and cultural surroundings, under the influence of which they grow, stagnate, deteriorate or vanish (Zioło 2008). These connections can also be translated to the relation between cities and their surrounding regions (Budner 2008). Throughout the last

decades, industry has seen significant shifts, based predominantly on economic changes. During this time, many firms have discontinued their operations, many have limited them, and many have changed. Industry was no longer in need of as much space, with the now unused areas becoming in need of redevelopment. The idea of the city reclaiming its valuable and central industrial lots by redefining their functions to ones adequate to their location and the needs of city dwellers is compatible with sustainable development policies.

The renewal of inner-city post-industrial areas is one of the paths to sustainable development. Unlike utilization of “fresh” suburban areas, it recycles areas that have already been developed (so-called *brownfields*) and enforces only the removal of waste and contamination that is appropriate to the specific new needs stemming from the new functions assigned to these areas. With such an approach, urban development can propel ecological sanitation (Tolle 2009). Just like the preindustrial city was replaced by the industrial, urban agglomerations can now, in accordance with the principles of sustainable development, create new, ecological urban systems that maintain a harmonious balance between culture and nature (Wehle-Strzelecka and Korczyńska 2007) and are based on more rational spatial development.

The aim of this work is to present, in the light of literature resources, the problem of managing the polluted post-industrial areas of the city, released from production activity. This problem is presented taking into account the genesis of industrial city centers in the context of changes resulting from economic development, specifying their pollution as barriers in development and evaluation of sanitation opportunities in the light of new legal regulations regarding soil and soil pollution assessment and reconciliation with the environmental protection plan remediation areas in historically polluted status. The paper attempts to answer the question whether new legal regulations regarding historical soil and soil pollution will be conducive to remediation of such areas and their re-use.

GENESIS OF INNER-CITY POST-INDUSTRIAL AREAS

In Poland, after the II World War, during a period of intense urbanization, undertakings connected to manufacturing were the main reason behind the creation of cities (Rydz and Szymańska 2006). Industrialization processes were often put ahead of urbanization processes (Klimczak 2004), meaning that the development of cities, tailored to the needs of the industry, violated their spatial order (Karwińska 2006). The period of socialist industrialization was characterized by mindlessness in regard to lot management (Gierańczyk 2006). In the years 1950–1970, the development of heavy industry was a priority (Bański 2007), which enforced high industrial concentration levels (Smętkowski 2008) in the form of aggregations, complexes, and industrial districts, which enabled the individual operators to each benefit from the proximity (Ziolo 2008). The following years saw the beginning of the process of distributing industrial investments more evenly, which resulted in a decrease of spatial disproportionality of industrial sites, technical infrastructure, residential conditions, and the quality of life of the citizens (Bański 2007). The quick development of cities resulted in significant growth in their populations, development of communication networks, massive residential construction projects, and the concentration of many businesses (Czochański 2007). Very many cities saw the appearance of new residential

districts, built without consideration for local urban traditions, constructed in the proximity of existing buildings or brutally integrated in existing, historical urban structures (Lorens 2005). The era's industrialization process resulted in the creation of mono-functional land use areas (Gierańczyk 2006). The leading production functions were assumed by complexes which either based on raw materials, were connected to heavy industry, or were heavily reliant on labor force (Zioło 2008). The countryside was a good source of simple resources, and, in return, the city exported the processed products and higher-end services back to said countryside (Budner 2008). A unique branch of industry, only present in some cities, was the shipbuilding industry. Shipyards were constructed in ports, located in the centers of cities, and therefore had a big influence on their development (Bending-Wielowiejski and Graczyk 2010).

During the turn of the 20th and 21st centuries, there was a shift from the industrial phase of growth to the post-industrial, initiated in Poland after the industrial production crash in the year 1989. The role of industry was weakened, predominantly due to the development of services and trade (Bański 2007), which was a result of the progressive servicing of the economy (Gierańczyk 2006). A general drop in the rate of employment in industry was observed, as well as a significant drop in the concentration of workers of large complexes (Rydz and Szymańska 2006). In the following years, thanks to the rapid technological progress (including automatization and robotization of production), the transformation occurred without drops of production output (Zioło 2008). The de-industrialization of the Polish economy reduced the contribution of industry in the creation of national income (Nelec and Prusek 2006). The turning away from heavy industry caused a decrease in or decay of the domination of industrial functions, typical for real-socialist cities (Karwińska 2006). Businesses of the time thus had to adjust to their new operational conditions (Rydz and Szymańska 2006). Survival in the era of transformative shock was achieved through cutting down staff, as well as getting rid of unused production assets and social infrastructure (May 2008). In the spatial dimension, these changes caused the abandoning of so-far occupied land and buildings (Zioło 2008). In extreme situations, whole cities or regions lost their industrial functions, with deindustrialization reduced solely to the destruction of industry instead of transforming and substituting it. The changes also concerned the spatial diversification of industrial planning, with a tendency of either spatially concentrating industrial complexes or fully distributing them (Zioło 2008). The phenomenon of spatial concentration of businesses was elevated, while other regions suffered stagnation or even recession as a result of their vanishing (Trojak and Wiedermann 2009). Another peculiar aspect was the whole range of temporary methods of development of post-industrial areas and buildings, such as lease for the purposes of small trade, storage or service-based operators (Rydz and Szymańska 2006). The growing competition also influenced the ongoing process of concentration of businesses through integration and the founding of increasingly large industrial organizations (Zioło 2008). However, at the same time, many post-industrial, inner-city areas became so-called brownfields, and the lack of their efficient conversion had a significant impact on the de-condensation of urban spatial structures. Once rapidly growing districts, due to the destroyed infrastructure and loss of industrial functions, ceased their role as city cores and instead became dysfunctional areas (Górczyńska et al. 2006), a reflection of the economic priorities of the past, and, in the new economic realm, simultaneously, a challenge (Mizgajski and Machnicki 2009).

In the post-industrial era, the physical location of a business is often assigned less significance (Gierańczyk 2008). The qualitative restructuring of industry revolves, among other things, around the fragmentation of production, where the majority of companies look for an optimal location that allows for manufacturing and completing the individual stages of production processes (Gierańczyk 2008). Industrial transformations in cities made attractive urban industrial spaces more available, but this came at a cost – ex-urbanization. Undoubtedly, the disappearance of industry from city centers is one of the positive effects of deindustrialization (Franta 2007). However, moving industry away from the city or a part of it (especially the central part) results in the export of such activities to other city districts or suburban locations (Gierańczyk 2006). The often-cited reasons behind external relocation are the possibility of territorial expansion, more freedom in regard to planning of the infrastructure, and separation of the complexes from other elements of urban life. Such external expansion of industry can be effectively avoided by revitalizing existing post-industrial areas (Lorens 2005).

Post-industrial cities are reaching limits in the development of alternative branches of the economy, set-out by environmental pollution regulations, attempts to avoid unattractive urban landscapes, a lack of sufficiently diversified communities, and a lack of social environments with significant growth potential (Karwińska 2006).

SPECIFICITY OF INNER-CITY POST-INDUSTRIAL AREAS

Apart from post-military, post-harbor, and post-rail areas, post-industrial areas are part of the category of problematic urban areas in need of renovation (Lorens 2005). A peculiar sub-group of this category are industrial brownfields, defined as abandoned, non-operational, and unused post-industrial areas (Gierańczyk 2006).

In the characteristics of inner-city post-industrial areas, their spatial specificity (the size and location of the premises), infrastructure (type, technical condition), and environmental conditions, especially in regard to soil and ground water (contamination of soil and land, strain caused by leftover waste) play a key role. Inner-city post-industrial areas are often very well connected (Gierańczyk 2006). They are also characterized by an atypical dispersal of green areas caused by a lack of consideration for the creation of organized systems of greenery (Cieślak 2006).

The unclear ownership of inner-city post-industrial areas is another common obstacle that prevents or delays the initiation of revitalizing renovations – especially when the unused area is degraded and requires the carrying-out of soil reclamation (Markuszevska 2009). The situation is worsened by the changes in ownership, which, despite the formal obligations of successors, prevent the enforcement of the obligation to pay compensation for the damage caused – in this case, pollution (Porębska 2005). At the beginning of the 21st century, urban post-factory areas owned by liquidators were divided into lots with no coherent plan. Currently, however, private investors ready to redevelop deteriorated spaces and institutions (such as industrial parks and business districts) begin to emerge, changing the municipal image and aesthetic value into an attractive product (Delowski 2011).

What is especially difficult is the development of inner-city post-industrial areas that house buildings featured in the register of historic buildings. The extraordinary legal regulations and costliness of any planned undertakings result in broad depreciation of unused development areas (Rydz and Szymańska 2006).

PERSPECTIVE FOR CHANGE

Increasingly often, post-industrial areas are used for non-manufacturing purposes, for example service-based operations (Rydz and Szymańska 2006). A desirable direction for so-far enclosed post-industrial areas is assigning them with an open, broadly available function. The ideal scenario would be to transform inner-city post-industrial areas into public spaces focused on free time and leisure, this way effectively competing with the attractiveness of shopping malls. The vanishing of industry from urban areas is also an opportunity to develop urban systems of green areas – however, such assignment can also be strongly argued in favor of residential, office, and communication functions (Mania and Kozacki 2008). The increased interest in the readapting of the functionality of post-industrial areas can be a sign of large touristic potential and good conditions for the development of industrial tourism (Czwartyńska 2008), revolving around the utilization of technical and industrial monuments for the purposes of creating an attractive touristic offer or enriching the existing one (Gierańczyk 2006).

The high cost of attractively (centrally) located post-industrial real estate means that only companies operating in highly-profitable industries have interest in their renting or purchase. The price of land therefore returns to the role of the single most important factor shaping the spatial structure of cities (Gierańczyk 2006). However, an increase in the significance of the price of ground rent also comes with a risk that the released post-industrial areas transform into a new, significant progress-hampering barrier through speculative purchasing of the most valuable lots and random assignment and localization of new functions (Gierańczyk 2006). Therefore, the interest of future generations should also be accounted for in revitalizing undertakings through the establishment of environmental easement in the form of an obligation of the owners of the individual lots to perform tasks and obey limitations in regard to environmental and landscape protection (Updated concept of national spatial planning, 2005).

The exceptional scope of deindustrialization of harbor cities after an age of a lack of appreciation for the benefits of “city waters” resulted in a “coastal renaissance”, making use of the proximity to water and the historical and symbolic values of the location (Górczyńska et al. 2006). This has the potential to reverse the industrialization-oriented tendency to turn the city “away from the river” (Tolle 2009). The relation of a city to its river is one of the most important criteria of assessing the craft of city planning and the ability to organize the functions of a city (Milecka and Brankiewicz 2008). The successful Swedish example of a transformation of a devastated post-shipyard area into a modern and balanced urban district of the city of Malmö is a perfect example of a well-balanced residential environment and redevelopment of abandoned and deteriorated premises of a historical shipyard.

CONTAMINATION OF INNER-CITY POST-INDUSTRIAL AREAS

The discontinuation of industrial operations allows for the transformation of “industrial wastelands” through an assessment of the state of contamination, undertaking of reclamation-oriented activities (decontamination), and redevelopment in the industrial function or assignment of new functions. However, a significant obstacle preventing innovative and productive utilization of post-industrial areas seems to be contamination that gives birth to legal, technical, and financial problems (Rulkens and Honders 1996). It is assumed that if a building was used for industrial purposes before the year 1980, there is a high risk that it is a contaminated site (Higgins 2008). In many places, especially those with a long history of industrial activity, even in sites where the once standing industrial buildings were demolished a long time ago, contaminated water and ground can still be found (Wołkowicz and Fajfer 2011). This is also confirmed by research conducted on soil in cities with an extensive industrial heritage, including in places currently used as post-industrial areas (Madrid et al. 2006).

In the research conducted by Kiepas-Kokot (2004), it was determined that pollution in industrial areas is characterized by a large diversity of concentration of heavy metals in the soil and land. This diversity is often accompanied by right-hand asymmetry, which indicates that high concentrations of heavy metals are not common. In such areas, there is no uniform model for the vertical distribution of metals, which, in turn, indicates that they may have infiltrated the soil in many different ways. The amount and types of metals in the soil in areas with long industrial histories depend on the types of production activity in said areas. The smallest concentration of metals is produced by operators in the food business, where metals are not used as raw materials, utilized in the production process, or used as essential ingredients. High metal contents in the soil can be found in areas in which metals were used as resources and materials (such as shipyards and cable, metal element, and mineral fertilizer factories). The soils of areas once home to specific branches of industry tend to contain the heavy metals that are typical for the specificity of the operations of said branches. For example, in an ex-wire factory, this metal is copper, which has to do with copper rolling, the fundamental resource used in such factories, while in a historical metalwork complex, the metals would be copper, nickel, and chrome, which, in turn, are the basic ingredients of Galvanic liquids. The research of Kiepas-Kokot (2014) also indicates that, after prolonged periods of exposition or risk of exposition of soils to metals, sealing and covering the soil is no longer a sufficient form of protection against contamination. In other words, sealings made of cement-based materials are not a fully effective barrier against pollution. Large amounts of metals stored on soil covered by both pavement blocks and concrete screeds do not prevent the exposure of the land to metals, which results in their increased concentration in the soil.

Heavy metal contents in the soils of inner-city industrial plant areas are a lasting footprint of the negative influence of industry on the environment. In the subject literature, these problems have been discussed to a much lesser extent than the negative effects of industry complexes on their surroundings through air and water pollution. Such an approach can be fully excused by the necessity of protecting the life and health of humans, who are in risk of exposure mostly to pollution present in our atmosphere. The complexity of environmental

protection obliges to the discovering of the state and protection of all elements of the environment, which includes the defining of the type and scope of so-called historical soil contamination, often with undetermined perpetration and difficulties in the realization of environmental protection policies, especially in regard to the financial liability of the parties behind the pollution. Soil and land located on the premises of industrial complexes is not regularly tested for pollution, wherefore the state and risks to the other elements of the environment are not sufficiently recognized, especially as the soil under manufacturing facilities cannot be treated as a uniform group with a universal profile.

Before the initiation of investment undertakings in post-industrial areas, information about pollution must be gathered – if pollution is detected, the premises must first be subjected to reclamation works (Wolkowicz and Fajfer 2011). Putting the premises back into use, as well as use in the existing function as an industrial area, requires significant resources for the decontamination of the soil, which is impossible to do without spending a major portion of the budget (Higgins 2008). The key to success here is to lower the value of the property by the costs connected to the risk and scope of the remediation, which can propel the economic reincarnation of post-industrial city centers (McGrath 2000). Private investors are rarely interested in making investments on degraded premises. Presented with a choice, they usually decide to invest in undeveloped, new areas (Markuszczyńska 2009). Independent financing of decontamination works by private owners limits the return on investment, which discourages from such undertakings (Higgins 2008). Local authorities care about the revival of unused land; however, the lack of sufficient public funds is a major obstacle, preventing any investments. The role of the local government therefore comes down to devising a system of encouragements and facilities for private entities to spark their investment undertakings. This especially concerns debt-reduction, improving infrastructure, introducing tax cuts, and decreasing lease costs (Markuszczyńska 2009). As an example, the city of Chicago undertook many initiatives to maximize the use of their “brownfields” by purchasing industrial real estate, decontaminating it, and coordinating the redevelopment of industrial areas. Chicago sees this as an opportunity to reverse the disadvantageous trend that causes the collapse of the city center by reusing their industrial areas and redeveloping them as green areas, affordable residential areas, etc. (Higgins 2008).

EVALUATION OF THE STATE OF HISTORICAL LAND AND SOIL POLLUTION

In the current legal situation, the state of land and soil is evaluated using examinations based on measurements of the concentration of substances that give rise to pollution-related risks, with contamination being defined as confirming the breach of the limit values of the concentration of these substances. The limit values represent a state in which none of the functions assumed by the land are yet significantly hampered. In this examination, the function of the land is determined on the basis of its use and development. In the case of post-industrial (unused) areas, the determination of its function is made on the basis of the land use plan, which defines the planned purpose for all lots.

Pollution created before 30.04.2007 or created by operators who discontinued their undertaking before the date, as well as damage to the land made as a result of emissions or events that happened more than 30 years ago qualifies as historical pollution of land and soil.

Since 05.09.2016, the evaluation is conducted on the basis of the ordinance of the Minister of the Environment of 01.09.2016 concerning the methods of evaluation of land pollution (OJ of 2016, pos. 1395; hereinafter referred to as: RMS), which replaced the ordinance of the Minister of Environment of 09.09.2002 concerning quality standards of soil and land. To identify a contaminated area, the type of operations that could be the reason behind the pollution (carried out currently or in the past) is determined, and a list of risk-inducing substances that are expected to be found is drafted. In further stages, all the available data is collected and analyzed, including any results of examinations that are essential for the evaluation of the pollution risk, after which initial research is conducted, and, if needed, followed by thorough research. The initial research has the purpose of verifying the suspicions of contamination. It begins with the devising of a map for the collection of samples. The samples are sourced at least two depths: 0–0.25 m below the surface (aggregate samples of the working area) and 0.25–1.0 m below the surface (individual samples). If there is a suspicion of contamination at more than 1 m below the surface, the samples are sourced deeper, in intervals of no more than 2 meters. The examination concerns both the properties needed to determine the limit values (particle size distribution, pH, organic carbon contents, hydraulic conductivity) and the contents of the noted risk-inducing substances. Thorough research is conducted to define the range of the pollution with risk-inducing substances found in the initial research.

REMEDICATION OF HISTORICAL LAND AND SOIL POLLUTION

After the legal identification of historical land and soil pollution, the owner of the premises should immediately pass on the information about said historical pollution to the regional environmental protection director, devise a remediation plan, and present it to the authorities for approval. An approval results in the issuing of a remediation resolution. Remediation is defined as the subjection of the soil, land, and ground water to undertakings with the purpose of removal or partial removal of risk-inducing substances, controlling them, and limiting their distribution so that the area ceases being a threat to human health or the environment, with consideration for the current and, if possible, planned land use of the area. The remediation can be focused on self-decontamination, provided that this option is the most advantageous to the environment (art. 3 paragraph 31b of the Act of April 27th, 2001, concerning environmental protection). In the current legal situation, due to the relatively subjective and vague criteria for the evaluation of the presence of significant danger to human health or the condition of the environment, the authority approving the remediation resolution may free the owner of the contaminated property from the obligation to carry out remediation.

From the initial experiences of the authors of works touching on the topic of remediation of post-industrial areas where historical soil and land contamination was found, it can be understood that the environmental protection agencies responsible for the approval of remediation projects and issuing of remediation resolutions strongly cooperate with the owners of the polluted areas. In the light of the authors' personal experiences, the applicable law concerning both the conduction of a pollution evaluation and remediation itself should be seen as encouraging sanitation of polluted inner-city post-industrial areas and preparation of said areas for redevelopment with more consideration for environmental protection regulations.

CONCLUSIONS

Economic development, less and less dependent on the location of plants in the spatial structure of cities, favors revealing the problem of undeveloped and polluted post-industrial areas in the city. The scientific achievements allow us to accurately identify the mechanism of relocation of industry from the central parts of cities, taking into account the specificity of the Polish post-industrial city. In scientific works, the advantages of the location of the post-industrial areas in the city are emphasized and it recognizes the potential of non-industrial development of cities. In original scientific works, the issue of barriers to their rehabilitation involving the contamination of soil is being increasingly addressed. Recognition of the specificity of pollution of post-industrial areas can be considered sufficient to assess the possibility of remediation, using the world scientific and practical achievements in the field of remediation techniques. Introduction of the historical status of soil pollution into the Polish legal order, standardization of soil and soil contamination assessment methodology and determination of remediation plan requirements and decision agreeing with the environmental protection authority create favorable conditions for undertaking remediation of post-industrial areas and their re-use for general city goals.

REFERENCES

- Bański J.** 2007. Koncepcje rozwoju struktury przestrzennej w Polsce – polaryzacja czy równoważenie? [Concepts of development of spatial structures in Poland – polarization or balancing?]. *Prz. Geogr.* 79(1), 45–79. [in Polish]
- Bendig-Wielowejski H., Graczyk T.** 2010. Problematyka funkcjonowania stoczniowych zakładów produkcyjnych na terenach silnie zurbanizowanych [The problematics of the functioning of shipyard complexes in heavily urbanized areas]. *Post. Nauki Techniki* 5, 15–22. [in Polish]
- Budner W.W.** 2008. Procesy metropolizacji i rozwoju metropolii w Polsce [The processes of urbanization and the growth of metropolises in Poland]. *Acta Sci. Pol., Administratio Locorum* 7(1), 5–16. [in Polish]
- Cieślak I.** 2006. Identyfikacja układu terenów otwartych w mieście Olsztynie [The identification of the lay-out of open areas in the city of Olsztyn]. *Acta Sci. Pol., Administratio Locorum* 5(1–2), 17–24. [in Polish]
- Czochański J.** 2007. Dezintegracja przestrzenna w rozwoju obszaru metropolii trójmiejskiej, w: *Waloryzacja środowiska przyrodniczego w planowaniu przestrzennym*. Red. M. Kistowski, B. Korwel-Lejkowska. Gdańsk, [b.w.], 195–207. [in Polish]
- Czwartyńska M.** 2008. Obszary pogórnice w postindustrialnej transformacji górnego Śląska [Post-mining areas in the post-industrial transformation of upper Silesia]. *Pr. Komis. Geogr. Przem.* Warsz. 10, 76–85. [in Polish]
- Delowski T.** 2011. Przekształcenia obszarów poprzemysłowych i możliwości finansowania zintegrowanych projektów rewitalizacji, w: *Rewitalizacja dziedzictwa przemysłowego*. Red. J. Kołodziej. Bydgoszcz, PAN, 101–109. [in Polish]
- Franta A.** 2007. Rola restrukturyzacji obszarów postindustrialnych w kreowaniu nowych rodzajów przestrzeni publicznych metropolii – stymulująca funkcja przyjętych regulacji [The role of the restructuring of post-industrial areas in the creation of new types of public spaces in metropolises – the stimulating function of the accepted regulations]. *Czasop. Tech. PKrak., Ser. Z* 1A, 35–43. [in Polish]

- Gierańczyk W.** 2006. Restrukturyzacja przestrzeni przemysłowej wybranych miast woj. Kujawsko-Pomorskiego w okresie transformacji ustrojowej [The restructuring of industrial areas in chosen cities in the Kuyavian-Pomeranian voivodeship in a period of political transformation]. Pr. Komis. Geogr. Przem. Warsz. 9, 62–72. [in Polish]
- Gierańczyk W.** 2008. Problematyka definiowania zmian w tendencjach lokalizacyjnych przedsiębiorstw przemysłowych w dobie globalizacji [The problematics of defining changes in the localization trends of industrial enterprises in the era of globalization]. Pr. Komis. Geogr. Przem. Warsz. 11, 86–97. [in Polish]
- Górczyńska M., Jusis U., Siłka P.** 2006. Wpływ rewitalizacji na rozwój miasta na przykładzie Cork w Republice Irlandii [The impact of revitalization on the development of a city portrayed in the city of Cork, northern Ireland]. Stud. Reg. Lokal. 3(25), 117–135. [in Polish]
- Higgins J.** 2008. Evaluating the Chicago brownfields initiative: the effects of city-initiated brownfield redevelopment on surrounding communities. Northwest. J. Law Soc. Pol. 3(2), 240–262.
- Karwińska A.** 2006. Zagrożenia funkcjonowania miasta, jako zbiorowości społeczno-przestrzennej. Przypadek miasta postsocjalistycznego [Threats to the functioning of cities as social and spatial collective units. A case of a post-socialist city]. Zesz. Nauk. WSE Bochnia 4, 62–73. [in Polish]
- Kiepas-Kokot A.** 2014. Zawartość wybranych metali ciężkich w glebach poddawanych wieloletniej działalności produkcyjnej. Monografia. Szczecin, ZUT, 99. [in Polish]
- Klimczak P.** 2004. Przemiany funkcjonowania wiodących przedsiębiorstw dawnego COP-u: Huty Stalowa Wola S.A. i Wytwórni Sprzętu Komunikacyjnego „PZL-Rzeszów” S.A. [Changes in the functioning of leading enterprises of the old COP group: Huta Stalowa Wola P.A. and Wytwórnia Sprzętu Komunikacyjnego PZL-Rzeszów P.A.]. Pr. Komis. Geogr. Przem. 7, 87–96. [in Polish]
- Kusińska E.** 2007. Miasto przyszłości – zrównoważona dzielnica mieszkaniowa [The city of the future – a balanced residential district]. Czasop. Tech. PKrak., Ser. A 3A, 163–169. [in Polish]
- Lorens P.** 2005. Porządek architektoniczny i urbanistyczny, jako element przestrzennego zagospodarowania kraju [Architectonic and urban order as an element of national spatial planning]. Stud. Reg. Lokal. 3(21), 21–50. [in Polish]
- Madrid I., Diaz-Barrientos E., Ruiz-Cortés E., Reinoso R., Biasioli M., Davidson C.M., Duarte A.C., Grcman H., Hossack I., Hursthouse A.P., Kraj T., Ijung K., Otabbong E., Rodrigues P., Urquhart G.J., Ajmone-Marsan F.** 2006. Variability in concentrations of potentially toxic elements in urban parks from six European cities. J. Environ. Monit. 8, 1158–1165.
- Mania W., Kozacki I.** 2008. Wpływ nowych form osiedli mieszkaniowych na system przyrodniczy miasta (na przykładzie osiedli piątkowskich w Poznaniu) [The impact of new forms of housing estates on the city's natural system (on the example of the piątkowskie settlements in Poznań)]. Probl. Ekol. Kraj. 22, 243–258. [in Polish]
- Markuszevska I.** 2009. Możliwości i ograniczenia zagospodarowania nieużytków poprzemysłowych. [Possibilities and limitations of utilizing post-industrial wasteland]. Probl. Ekol. Kraj. 24, 17–23. [in Polish]
- May J.** 2008. Adaptacja przedsiębiorstw przemysłowych – przykład Łodzi [Adaptation of industrial enterprises – example of Łódź]. Pr. Komis. Geogr. Przem. Warsz. 10, 154–172. [in Polish]
- Mcgrath D.T.** 2000 Urban industrial land redevelopment and contamination risk. J. Urban Econ. 47, 414–442.
- Milecka M., Brankiewicz I.** 2008. Radomka w Radomsku – znaczenie rzeki w strukturze miasta przemysłowego [The Radomka river in the city of Radomsko – the importance of rivers in the structure of industrial cities]. Probl. Ekol. Kraj. 22, 305–314. [in Polish]
- Mizgajski A., Machnicki E.** 2009. Prawidłowości w zagospodarowaniu terenów poprzemysłowych. Przykład Poznania [Principles of development of post-industrial areas. A case of Poznań]. Probl. Ekol. Kraj. 24, 115–124. [in Polish]

- Nelec W., Prusek A.** 2006. Funkcje państwa i specjalnych stref ekonomicznych w Polsce w zakresie innowacyjności i konkurencyjności gospodarki [The role of the government and special economic zones in innovation and the competitiveness of the economy in Poland]. Zesz. Nauk. AE Krak. 709, 19–37. [in Polish]
- Porębska G.** 2005. Nowa jakość przyrody i krajobrazu na terenach poprzemysłowych [The new quality of nature and landscape in post-industrial areas]. Ochr. Środ. Zas. Natur. 28, 15–23. [in Polish]
- Rulkens W.H., Honders A.** 1996. Clean-up of contaminated sites: experiences in the Netherlands. Wat. Sci. Tech. 34(7–8), 293–301.
- Rydz E., Szymańska W.** 2006. Efekty restrukturyzacji słupskiego ośrodka przemysłowego w okresie wdrażania gospodarki rynkowej (na wybranych przykładach) [The effects of restructuring of the industrial area of Słupsk in the period of the introduction of the market economy (chosen examples)]. Pr. Komis. Geogr. Przem. Warsz. 9, 40–51. [in Polish]
- Smętkowski M.** 2008. Rola specjalnych stref ekonomicznych w kształtowaniu struktury przestrzennej przemysłu w Polsce [The role of special economic zones in the shaping of the spatial structure of industry in Poland]. Pr. Komis. Geogr. Przem. Warsz. 10, 204–216. [in Polish]
- Tolle A.** 2009. Przekształcanie terenów poprzemysłowych w Berlinie według „Dziesięciu postulatów zrównoważonego rozwoju miast nad wodą” [The redeveloping of post-industrial areas in Berlin according to “The ten principles of sustainable development of waterside cities”]. Probl. Ekol. Kraj. 24, 101–113. [in Polish]
- Trojak A., Wiedermann K.** 2009. Specjalne strefy ekonomiczne i strefy przemysłowe w kształtowaniu rozwoju gospodarczego regionów na przykładzie Polski i Czech [Special economic zones and industrial zones and their influence on the economic development of their regions on the basis of Poland and the Czech Republic]. Pr. Komis. Geogr. Przem. 12, 133–143. [in Polish]
- Wehle-Strzelecka P., Korczyńska A.** 2007. Ochrona środowiska w kształtowaniu współczesnej przestrzeni miejskiej w aspekcie idei ekologii miasta [Environmental protection in the shaping of modern urban spaces from the perspective of the idea of urban ecology]. Czasop. Tech. Z 7-A/2007, 55–64. [in Polish]
- Wołkowicz P., Fajfer J.** 2011. Problematyka terenów zdegradowanych: uwarunkowania prawne i możliwości, w: Rewitalizacja dziedzictwa przemysłowego. Red. J. Kołodziej. Bydgoszcz, PAN, 27–34. [in Polish]
- Zaktualizowana koncepcja przestrzennego zagospodarowania kraju.** 2005. Warszawa, Rządowe Centrum Studiów Strategicznych, 139.
- Zioło Z.** 2008. Problemy badawcze struktury przestrzennej przemysłu [Research problems of the spatial structure of industry]. Pr. Komis. Geogr. Przem. Warsz. 11, 9–24. [in Polish]

Abstract. A city's post-industrial areas are a reservoir of attractive urban space which can both be reused for industrial purposes or managed in a different way. The economic transformation of the post-industrial era caused a high availability of brownfields in modern cities, mostly as a result of high costs of maintaining production in central locations. The available spatial resources were not suited for the needs of modern, concentrated, automated and fragmented production processes. The early industrial model of development enforced spatial development of cities that was tailored to the needs of industry. Revitalization of these areas is an opportunity for their efficient use. The main barrier in this process is, inter alia, soil contamination, which is poorly researched, highly varied, and expensive in liquidation. Soil and land contamination of brownfields is a permanent footprint of many years of high industrial pressure and it is substantially less considered than the environmental state of the surroundings of said brownfields. The pollution of soil within the areas of former industrial plants is often accompanied by the left-behind decaying infrastructure. Waste collected in industrial facilities can also be problematic. The characteristics of industrial sites in city centers strongly limit the possibilities of transformation. New legal regulations, which introduce historical soil contamination statuses and remediation plans, are an important stimulus for the intensification of processes of transformation of the industrial areas of city centers through the improvement of their ecological status and can, thus, be an effective path to sustainable urban development.

