

URBAN INDUSTRIAL BROWNFIELDS: CONSTRAINTS AND OPPORTUNITIES IN ROMANIA

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Abstract: This article approaches different aspects of urban industrial brownfields in Romania. The analysis comprised 60 cities of different sizes, many of which having large factories before 1989, factories that are now closed. The spatial position and the area occupied by industrial brownfields have been analyzed for each city. A number of 222 industrial brownfields have been identified, with surfaces ranging between 0.13 ha and 1137.49 ha; the share of brownfield sites in the structure of the urban land ranges between 0.42% (Cluj-Napoca) and 87% (Călan) of the built-up area. The study revealed patterns of spatial distribution of brownfields in relation to the built-up area (compact spatial pattern, bipolar compact spatial pattern, dispersed spatial pattern) as well as the main dysfunctions induced by them. The brownfield / urban green space ratio shows that, for many of the cities, an undesirable grey-city label is emerging, the value of this ratio ranging between 1.04 and 178.44. Actions that can be performed for a proper management of urban industrial brownfields should be part of the following categories: environmental rehabilitation, functional redevelopment, or architectural conservation (if there are buildings that have been or may be classified as monuments). The main obstacles hampering a rapid functional reintegration process are represented by legislative gaps, lack of studies showing the exact type and intensity of contamination, decontamination costs, lack of urban development policy focusing on brownfields, the failure to earn resources for their management, and real estate aspects. Starting from the question "For whom do we plan?", the targeted redevelopment opportunities aiming to eliminate the repulsive character, adopting sustainable development patterns and increasing the quality of urban life.

Keywords: brownfield, dysfunction, constraint, opportunity

1. INTRODUCTION

Romania's industry has seen a significant increase between 1970 and 1989, as the result of a centralized economic approach, allocating 50-60% of all investments to the industrial sector (Popescu, 2000), so that the growth rate was a high one. Effects have resulted in both number of industrial units and territorial distribution. This process was simultaneous with the process of urbanization, both having comparable growth rates between 1948–1992 (idem).

Industry decline, caused by the change in economic and political regime in Romania after 1989, represented a problem with effects that can still be felt today. Besides the economic and social, industry decline also has an important spatial connotation, the former industrial sites turning, in many cases, into physically and environmentally

degraded areas. The inefficiency or lack of industrial units closure plans, of environmental redevelopment plans and territorial reconversion plans generated some categories of urban areas with a special concern: urban industrial brownfields.

For Romania, there is little analysis of the current situation, of the general issues, and few case studies on brownfields. They include reports and general evaluations conducted by Concerted Action on Brownfield and Economic Regeneration Network (Oliver et al., 2005), Network for Industrially Contaminated Land in Europe (NICOLE Brownfield Working Group, 2011), World Bank reports (World Bank, 2010), consultancy reports conducted for the benefit of certain institutions (e.g. the study conducted for the benefit of the Ministry of European Integration, within the "Reactivation of Derelict Industrial Sites in Romania" project, by Gesellschaft für Internationale Zusammenarbeit,

according to Schock & Hirschberger 2007), and scientific articles. The latter generally approach aspects regarding brownfield redevelopment (Vanheusden, 2007, Gavrilidis et al., 2011), policies, administrative and financial instruments that could be used in their management (Cobârzan, 2007, 2008). Only a few of them have considered an inventory of brownfields at regional scale (Filip, 2009a), while at national level, the approaches are mostly focused on issues regarding contaminated sites.

Considering the background described above, the study aims to identify the dysfunctions induced by industrial brownfields in the urban systems and the possible solutions for their functional redevelopment.

2. MATERIALS AND METHODS

The analysis of aerial photographs, brownfield sites investigation and brownfields mapping were all carried out. An important aspect of the analysis is the identification of spatial patterns of brownfield location in relation to the built-up area and the quantitative relationship between the surface of brownfield sites and that of the built-up area of cities, both in general and in individual cases. The national and international legislative approach to this category of land has also been analyzed.

A major issue in this study was represented by brownfield sites delimitation criteria. Theoretical approaches on the definition of brownfield sites are numerous, being developed by specialists in various fields such as that of environmental protection, national planning, administration, with additional studies undertaken by teams of specialists, institutions or government departments, NGOs (Alker et al., 2000). For example, according to CABERNET (Concerted Action on Brownfield and Economic Regeneration Network), brownfields are “sites that have been affected by the former uses of the site and surrounding land; are derelict and underused; may have real or perceived contamination problems; are mainly in developed urban areas; and require intervention to bring them back to beneficial use”.

The importance of an accurate and singular definition is highlighted in many of the studies. For example, the approach to brownfield sites as contaminated land in the national law, and their statistical accounting from this perspective, results in ranking Romania as the first country in Europe in terms of surface (900,000 ha) and density of such sites (Oliver et al., 2005). Such an approach is too general. By adopting the definition (polluted land)

and the working methodology of the Environmental Protection Agency, including currently used land with a territorial viability, but affected by accidental or historical pollution associated to air pollutants emitted by some plants (e.g. including residential areas of Baia Mare or agricultural land near Copsa Mica) in the category of those with historical pollution is definitely correct, but it is not acceptable to include these areas in the category of brownfield sites. In addition, a series of lands that meet the acknowledgement above (previously developed land) can lack any acute or chronic types of pollution. Undoubtedly, the presumption of pollution can be considered when it comes to industrial brownfield sites, as it appears in these definitions: real or perceived contamination problems.

This study starts from the definition of brownfield sites as “previously developed land” (Department for Communities and Local Government, UK, 2011) and as “abandoned, idled or under-used industrial and commercial site where expansion or redevelopment is complicated by real or perceived environmental contamination; it has an active potential for redevelopment or reuse” (U.S. Congress, 2002). But not all polluted industrial lands can be included in the category of brownfields. In these circumstances, the identification and mapping of these sites only referred to land that met the characteristics explicitly specified in the definition above.

The selection of the cities to be analyzed was done according to the following criteria: the existence of one or more large industrial units with total or partial ceased operation, so that the afferent surfaces correspond to the definition (1); those sites are within the built-up area, or in the administrative territory of the city (2).

Most cases are represented by cities with factories that were once part of the manufacturing industry, with a decline that has led to the depreciation of production and storage spaces. A special category is that of brownfields generated by ceased surface mining. These situations are less numerous but are characterized by the presence of more extensive areas, as it is the case of the mining towns of Motru and Rovinari in the Getic Plateau, or the towns along the Jiu Valley (Petroșani, Petrița, Lonea).

A number of 60 out of the 320 existing cities in Romania have been analyzed (Fig. 1). They are of different sizes, with a population between 3,315 inhabitants (Anina) and 315,214 inhabitants (Iasi), together with the capital of Romania, Bucharest (1,931,838 inhabitants).

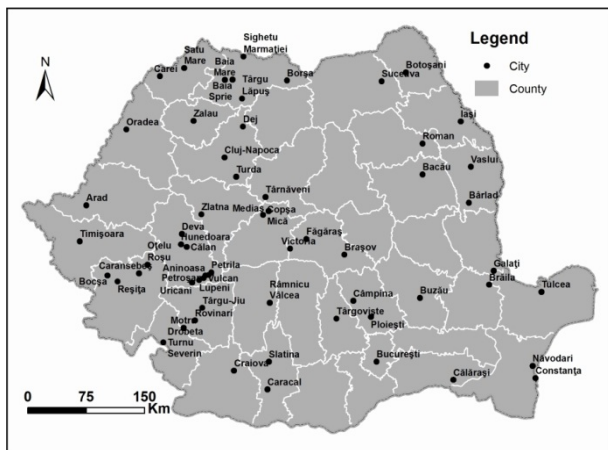


Figure 1. The geographical position of the analyzed cities.

3. RESULTS

Based on the criteria mentioned above, a number of 222 industrial brownfields have been identified, with surfaces ranging between 0.13 ha (brownfield in Victoria city) and 1137.49 ha (brownfield near Rovinari town). The total area of these brownfield sites is 11345.6 ha.

The quantitative analysis indicates that the size and distribution of such land has different aspects (Table 1). For example, in terms of industrial brownfields per inhabitant, the highest values are typical for small and medium-sized towns where there have once been industrial units of great dimensions. The following towns are part of this category: Zlatna, Calarasi, Calan, Copsa Mica, with areas of over 100 m² per capita. In contrast, Cluj-Napoca city has the lowest value (0.58 m² per capita) because, on the one hand, the city has a large population (> 300,000) and, on the other hand, in recent years, part of the existing brownfields have been redeveloped.

In terms of location, the identified brownfield sites are either located within the built-up area, or at the border of the built-up area, or outside the built-up area. As the maximum interference is related to the built-up area, the analysis of the distribution pattern of industrial brownfields in relation to it has been assessed.

Three major categories of spatial patterns have been identified: *compact spatial pattern*, specific for cities where brownfields are represented by one or more areas arranged according to the spatial contiguity principle; *bipolar compact spatial pattern*, characterized by the grouped distribution of brownfield sites into two distinct areas, often positioned in two opposite sides of the city; *dispersed spatial pattern*, characterized by the insular distribution of brownfield sites within the urban system; they can occasionally be

grouped into brownfield clusters, which dominate the urban area and generate a specific urban fabric.

3.1. Spatial Constraints

For the studied cities, the total area of industrial brownfields ranges between 6.3 ha and 3,497 ha. The share of brownfield sites in the structure of the urban land ranges between 0.42% (Cluj-Napoca) and 87% (Calan) of the built-up area. The performed analysis shows that the largest brownfield sites appear in cities that once had important steel and metallurgical industry (Calan, Resita, Tulcea, Baia Mare, Galati, Hunedoara and Calarasi), chemical industry (Tarnaveni, Fagaras), and manufacture of machinery and equipment.

Table 2. Spatial patterns of industrial brownfield distribution

Pattern of brownfield spatial distribution	Name of city
Compact spatial pattern	Bacau, Barlad, Copsa Mica, Navodari, Oradea, Otelu Rosu, Roman, Satu Mare, Sighetu Marmatiei, Slatina, Deva, Calan, Bocsu
Bipolar compact spatial pattern	Braila, Brasov, Drobeta – Turnu – Severin, Medias, Targu Jiu, Tulcea, Turda, Uricani, Zalau, Baia Sprie
Dispersed spatial pattern	Arad, Baia Mare, Resita, Borsa, Botosani, Bucuresti, Buzau, Calarasi, Campina, Caracal, Caransebes, Carei, Cluj-Napoca, Constanta, Craiova, Hunedoara, Fagaras, Galati, Iasi, Motru, Rovinari, Ramnicu Valcea, Suceava, Tarnaveni, Timisoara, Zlatna, Victoria.

A particular category is that of the cities of Rovinari and Motru whose economy depended for a long period of time on coal mining. The difficult environmental rehabilitation of this type of mining kept these areas in the category of brownfields for long periods of time. The two cities are dominated by these lands that are placed on both the administrative territory and the peri-urban areas. Their surface largely exceeds the built-up area (1108% in Rovinari and 330% in Motru). Even though none of these cities feels an acute need for expansion (as the economic downturn has affected all the structural components of their system), the presence of such land scars is a major problem.

Table 1 Quantitative indicators of urban industrial brownfield - UIB and urban green space – UG (based on the data delivered by the National Institute of Statistics and the National Environmental Agency, Romania)

City name	Built up area (ha)	Brownfield area			No. of inhabitants	Brownfield area - UIB (m ² /inhabitant)	Urban green space - UG (m ² /inhabitant)	UIB/UG ratio
		Total (ha)	% from built up area	% from administrative area				
Aninoasa	131,6	12,5	9,5	0,4	3315	37,7	0,7	48,4
Arad	3610,2	64,1	1,7	0,2	167238	3,8	5,2	0,7
Bacau	2070,3	21,6	1,1	0,5	178203	1,2	17,8	0,1
Baia Mare	2673,5	354,9	13,2	1,4	139870	25,3	16,2	1,5
Baia Sprie	544,2	33,6	6,1	0,3	16423	20,5	20,7	0,9
Barlad	900,3	53,6	5,9	3,7	70064	7,6	14,4	0,5
Bocsa	534,1	30,6	5,7	0,2	17168	17,8	27,8	0,6
Borsa	5923,4	84,1	1,4	0,2	27888	30,1	14,3	2,1
Botosani	1296,1	92,4	7,1	2,2	115739	7,9	28,1	0,2
Brasov	2923,94	188,3	6,4	1,2	277945	6,7	19,1	0,3
Braila	2214,4	293,8	13,2	6,5	215316	13,6	19,5	0,7
Bucharest	17432,2	114,1	0,6	0,4	1931838	0,5	23,0	0,1
Buzau	1660,1	59,4	3,5	0,7	134619	4,4	12,9	0,3
Caracal	676,7	136,3	20,1	1,9	35577	38,3	12,0	3,1
Caransebes	591,4	60,2	10,1	0,8	28966	20,8	19,9	1,1
Carei	786,1	31,3	3,9	0,3	22611	13,8	26,9	0,5
Calan	227,2	198,2	87,2	1,9	12938	153,2	23,3	6,5
Calarasi	1097,5	874,7	79,7	6,5	73823	118,4	5,8	20,2
Campina	803,2	59,1	7,3	2,4	38017	15,5	18,0	0,8
Cluj-Napoca	4248,7	17,9	0,4	0,1	310243	0,5	20,2	0,1
Constanta	3471,3	265,5	7,6	2,1	304279	8,7	5,1	1,7
Copsa Mica	181,4	158,2	87,2	6,1	5441	290,9	21,2	13,7
Craiova	3108,6	34,2	1,1	0,4	299429	1,1	27,2	0,1
Dej	592,7	47,7	8,1	0,4	38610	12,3	19,4	0,6
Deva	793,6	19,8	2,5	0,3	67508	2,9	3,6	0,8
Drobeta-Turnu	1103,9	47,7	4,3	0,7	107882	4,4	14,7	0,3
Fagaras	922,6	292,3	31,6	8,2	38921	75,1	11,7	6,4
Galati	2355,3	423,9	18,0	1,7	293523	14,4	2,6	5,4
Hunedoara	1222,7	580,1	47,4	5,9	71207	81,4	23,6	3,4
Iasi	3284,6	165,6	5,1	1,7	315214	5,2	20,6	0,2
Lupeni	642,5	154,5	24,1	2,1	4486	344,6	9,9	34,8
Medias	898,9	17,8	1,9	0,2	53564	3,3	15,3	0,2
Motru	245,1	811,3	330,9	16,1	22930	353,8	14,6	24,2
Navodari	413,3	113,4	27,4	1,8	34936	32,4	13,4	2,4
Oradea	3756,7	54,7	1,4	0,4	205077	2,6	24,3	0,1
Otelu Rosu	313,1	91,8	29,3	1,5	11902	77,1	23,1	3,3
Petrla	575,3	22,2	3,8	0,1	25361	8,7	20,3	0,4
Petrosani	781,6	75,9	9,7	0,3	43948	17,2	15,3	1,1
Ploiesti	2781,6	49,9	1,7	0,8	230240	2,1	6,9	0,3
Ramnicu Valcea	604,3	17,3	2,8	0,2	111342	1,5	13,9	0,1
Resita	750,6	260,1	34,6	1,3	84678	30,7	13,0	2,3
Roman	1029,2	38,7	3,7	1,3	69058	5,6	7,2	0,7
Rovinari	315,5	3497,9	1108,4	132,4	13164	2656,7	14,8	178,4

Satu Mare	2281,4	34,7	1,5	0,2	113688	3,1	22,9	0,1
Sigetu Marmatiei	863,6	17,5	2,1	0,1	41640	4,2	2,9	1,4
Slatina	1382,7	137,8	9,9	2,8	78570	17,5	14,7	1,1
Suceava	1819,6	121,5	6,6	2,3	106397	11,4	22,3	0,5
Targoviste	1057,8	100,7	9,5	1,8	89773	11,2	21,8	0,5
Targu Jiu	1015,7	99,1	9,7	0,9	96081	10,3	6,5	1,5
Targu Lapus	406,7	6,3	1,5	0,1	13114	4,8	14,2	0,3
Tarnaveni	648,3	139,6	21,5	2,2	26504	52,6	12,7	4,1
Timisoara	4433,9	80,3	1,8	0,6	307347	2,6	15,9	0,1
Tulcea	1312,9	272,3	20,7	1,3	92379	29,4	11,5	2,5
Turda	1271,1	84,6	6,6	0,9	57381	14,7	4,7	3,1
Uricani	162,2	33,4	20,6	0,1	9750	34,3	68,6	0,5
Vaslui	584,3	26,7	4,5	0,3	70302	3,8	21,0	0,1
Victoria	309,5	32,1	10,3	17,3	9132	35,1	7,3	4,8
Vulcan	452,1	22,2	4,9	0,2	29108	7,6	3,1	2,4
Zalau	1007,7	43,4	4,3	0,4	63642	6,8	18,4	0,3
Zlatna	360,7	88,2	24,4	0,3	8335	105,9	7,3	14,5

The *urban zoning* reveals two main shortcomings. The first is the lack of transition zones between brownfield sites (former industrial areas) and neighboring areas, therefore their "contamination" and urban decline is much faster. The urban decline of the residential areas is based on visual aspects associated with physical damage and possibly, with additional pollution. The second drawback is related to the spatial distribution of brownfield sites in urban areas (Table 2, Fig. 2), thus contributing to their constitution as nuclei of certain networks of degraded urban areas, more difficult to manage and isolate in terms of their contagiousness in relation to the neighboring areas.

In terms of urban functionality, the main problem is related to the establishment of some repulsive areas, avoided by both citizens and potential real estate investors. The major constraints are

generated when industrial brownfields are dispersed within the urban fabric and have large surfaces. The cities of Constanta and Resita, Victoria and Fagaras are the most affected by this situation. In these cases, the brownfields are located both at the periphery and inside the built-up area of the city, thus affecting areas with highly important urban functionality (residential, recreational, green areas, open urban spaces).

3.2. Environmental Constraints

Brownfield repulsiveness is frequently increased due to contamination. Depending on the pre-existing industrial activity, the type and concentration of pollutants can vary within large limits. The most affected are the brownfields associated to former chemical, metallurgical and steel plants.

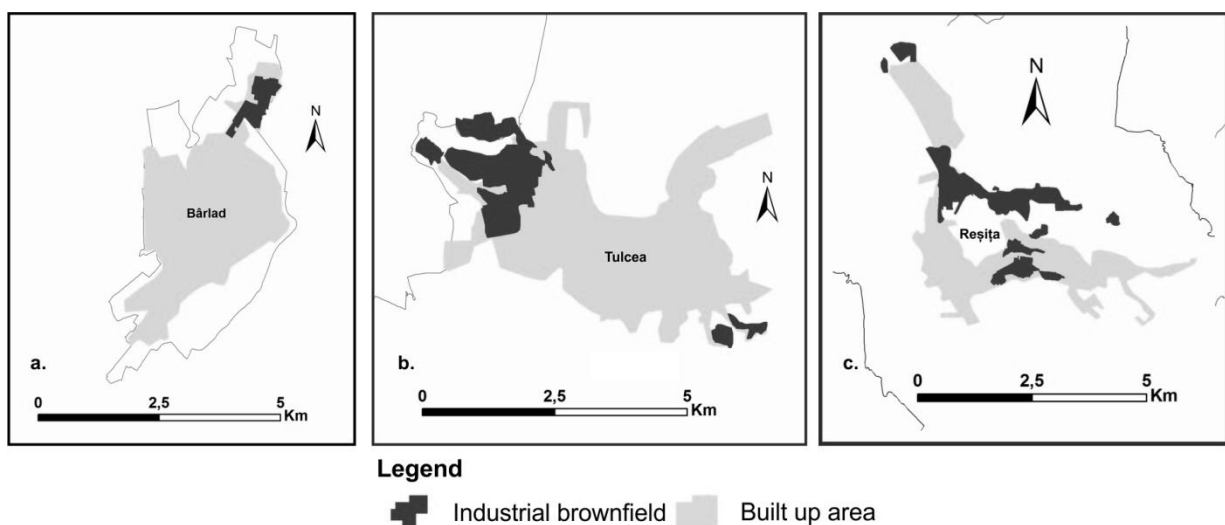


Figure 2. Spatial patterns of industrial brownfield distribution: compact pattern (a); bipolar compact pattern (b); dispersed pattern (c).

In the case of former non-ferrous metallurgical plants, soil contamination resulted from slag deposit formation as well as air emissions and acid rain (Damian et al., 2008b). Exceeding alert thresholds in various pollutants were highlighted in several specialized studies conducted for various cities in Romania. They refer to high levels of lead, copper, zinc and cadmium, their presence affecting, according to the local dispersion conditions, both brownfields and the rest of the urban and suburban space. The following cities belong to this category: Copsa Mica, where heavy metal pollution is associated with high carbon black pollution (Damian et al., 2008b, Oros et al., 2009, Muntean et al., 2010), Baia Mare (Damian et al., 2008a, Damian et al., 2010) and Zlatna (Damian et al., 2008b).

Another specific problem occurs in cities where various industrial plants ceased operations. The result was mosaic pollution on the one hand and the existence of complex polluted brownfields. This is the situation of cities such as Iasi (Secu et al., 2008, Iancu & Buzgar, 2008) și București (Rizea et al., 2011), where many brownfields are affected by pollutants such as heavy metals and organic compounds with concentrations exceeding the normal values or even the specific alert level.

Worldwide studies indicate that the presence of pollutants in brownfields is of critical importance in relation to public health (Litt et al., 2002). Vegetation scarcity on these lands favors the increase in atmospheric dust (thus, some of these pollutants will be found in the air), and infiltrating pollutants will lead to groundwater contamination. Such conditions affect the environmental quality of residential areas in close proximity, contributing to an increased incidence of respiratory diseases, cancer and cardiovascular diseases (Schell & Denham, 2003, Pope et al., 2002).

3.3. Opportunities

The existence of industrial brownfields is only one of the negative aspects that the urban planning in Romania is facing. The architectural stereotypes, the monotony and dull character of the workers' districts, the predominance of concrete surfaces, and the lack of natural elements are other aspects that shape the urban features of Romanian cities. Unfortunately, the last 20 years of urban practice have been dominated by a *laissez - faire* attitude encouraged by an incomplete approach and flawed legislation, without a conceptual support anchored in the principles of modern urban planning, oriented towards the needs of the individual and of the society. There is also an addition of other structural or functional aspects that

authorities and planners should consider, increasing the quality of urban life being directly linked to solving these problems. There are aspects of green space management, creating attractive urban neighboring residential areas for pedestrian and non-motorized use, creating public spaces that encourage social interaction, etc. These are necessary and mandatory elements in terms of modern concepts that should govern the urban practice (Beatley, 2000; Plater - Zyberk, 1999; Platt, 2006; Downton, 2009).

Actions that can be performed for a proper management of urban industrial brownfields should be part of the following categories: *environmental rehabilitation*, if the sites are affected by various types of pollution; *functional redevelopment*, through the development of some economic activities or the conversion into open public spaces (squares, parks, sports fields, etc.); *architectural conservation*, if there are buildings that have been or may be classified as monuments.

In addition, the importance of urban zoning, with a physical separation of industrial sites from other areas through green corridors is also noted. Thus, their possible decline could be reduced by the presence of natural elements, having an aesthetic and ecological role.

Because of the needs, whether aware or not, that the urban individual has, the relationship with the natural elements is undoubtedly one which should be considered by the authorities as a prerequisite that can help generate a pleasant and attractive urban environment. Under these conditions, the presence of industrial brownfields must be approached as an opportunity to rehabilitate the quality of urban green spaces. The necessity of such an approach is supported by statistic data showing that, for most cities in Romania, the green space area is insufficient in terms of quantity and also with deficiency in terms of accessibility and characteristics. For example, considering a recommended area of 26 square meters per capita, many cities have much lower values (Table 1).

The problem of transforming brownfields into urban green space was frequently addressed in urban planning works. The benefits of brownfield greening include those related to biodiversity conservation (Harrison & Davies, 2002; Kong et al., 2010; Hostetler et al., 2011). Equally important are the issues related to the social function that the new green urban areas may have (Zukin, 1995). The way in which brownfield greening occurs requires special attention so that the result is a sustainable one (Moffat & Hutchings, 2007).

Data analysis on the surface of green space per capita shows that most cities analyzed (56 cases)

do not meet the minimum standards for this indicator. In addition, brownfield/urban green space ratio shows that, for many of the cities (e.g. Calarasi, Fig. 3), an undesirable *grey-city* label is emerging, the value of this ratio ranging between 1.04 and 178.44. These two characteristics lead to the need for redevelopment measures suitable for the new urban green space function.

The need for an accurate inventory of brownfield sites (Simons & Jaouhari, 2001) is required in all cities that have such areas. In terms of urban planning and environmental management, such an inventory should include information on the general conditions of the buildings, the neighboring areas, and the construction/demolition works (Hula & Bromley-Trujillo, 2010). These should be joined by information about the exact type and intensity of contamination, decontamination costs, the legal provisions and the citizens' opinion on their needs and expectations regarding the redevelopment of these areas.

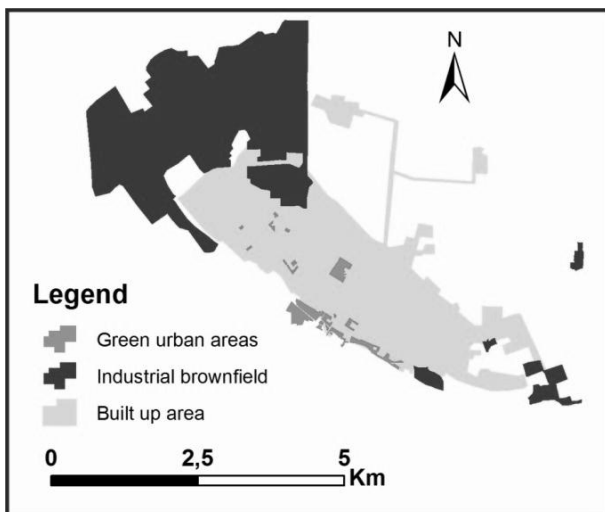


Figure 3. Calarasi. City dominated by industrial brownfields.

Architectural conservation, doubled by physical rehabilitation of buildings, is an option that should be considered especially in cases of factories with historical importance, either in terms of technological processes or in terms of industrial architecture. The problem of preserving inherited urban structural elements is undoubtedly an issue that involves an approach where urban planning also assumes managerial aspects of a palimpsest structure. In these circumstances, it is necessary that different "layers" in the evolution of the city, with inherited physical elements, with cultural symbolism and value, must find their natural place, side by side, in a controlled harmony generated by urban development plans. Selection criteria, objectives and strategy for preserving inherited elements

(Ashworth, 2007) are milestones that should be considered when elaborating these plans.

So far, the National Spatial Development Plan (Parliament of Romania, Law no.5 / 2000) includes few industrial sites designated as "monuments". The analyzed cities include only a small number of such industrial sites: the furnace in Resita (commissioned in 1771), the furnace in Calan (1870), Malaxa Plants in Bucharest (1928-1930), and Assan's Mill in Bucharest (1853). There are few additional industrial and architectural structures of this kind that were included in the List of Historical Monuments (Ministry of Culture and National Patrimony, 2010). Unfortunately, the way they are preserved makes them correspond, in many cases, to the definition of industrial brownfields, i.e.: previously developed land, abandoned, derelict. The complicated legislation results in an uncertain managerial responsibility towards these monuments, divided between the Ministry of Culture and the town halls, with divergences on this topic. The capitalization of a distinctive urban element must definitely be part of the general urban plans, so that they will be vectors for a future development also based on the valuation of the past. The lack of such an approach leads to a continuous physical degradation of some monuments or structures having the potential of becoming monuments, and can even lead to their disappearance.

In terms of urban planning, the redevelopment of these lands must consider three major aspects: environmental redevelopment (ensuring the lack of elements dangerous to human health), structural redevelopment (ensuring the integration into the urban system), and functional redevelopment (ensuring the harmonization with the urban fabric). The last two categories provide multiple use possibilities fitting in the necessary process of urban rehabilitation.

The functional redevelopment and reintegration projects implemented were often the result of the initiative of investors who purchased the land in question and used it to carry out other economic activities or real estate projects. There are few cases of brownfield redevelopment benefiting from the development of projects initiated by local decision makers (town halls), resulting in functional urban areas. However, there are also few cases of local authorities using strategic planning documents that approach urban development as a holistic and integrating process (e.g. Craiova, according to Cocean, 2011). For the large cities, brownfield redevelopment is mostly associated with the development of shopping centers and only a small number of cases correspond to the development of some activities similar to the initial ones.

Despite a shortage of housing, there are few situations of developing residential real estate projects on industrial brownfields (e.g. Iris residential project, about 2000 apartments in Cluj-Napoca, developed on the site of a former porcelain factory). There are fewer planning projects for public spaces with a functionality that could increase the quality of life for the residents of the neighboring areas by creating green spaces (Hoffmann et al., 2010), sports fields, walking areas, etc. Urban planning practice in Romanian cities has shown that the transformation of industrial brownfield sites into urban green space is the last solution taken into consideration (with no examples of implementation). This situation is undoubtedly the result of a combination of two key factors: the private interests (Fig. 4) and the lack of a sustainable urban development vision (urban policies and allocation of funds).

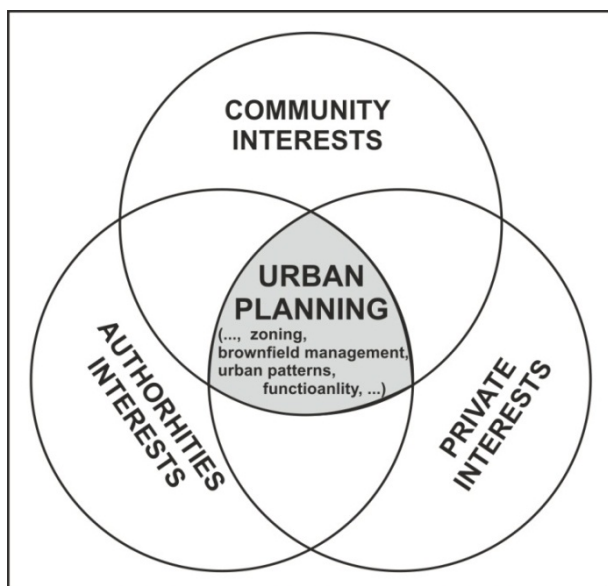


Figure 4. Areas of interest manifested in relation to urban planning (Filip, 2009b, modified).

In terms of functional reintegration and redevelopment, the territorial dynamic of industrial brownfield sites records various trends. Thus, it appears that for large cities, most of the areas have the status of abandoned areas for relatively short periods of time. This is due to the modernization of factories, or to the real estate attractiveness these lands generate. Among the analyzed cities, most of the redevelopment processes occurred in the case of brownfield sites in Bucharest, Cluj-Napoca, Brasov, Oradea, and Timisoara. The benefits of such a dynamic are: the limitation of greenfield-type development, the adoption of a development pattern through urban densification and the avoidance of neighboring areas degradation. Small towns are

characterized by a much lower redevelopment rate, so that two phenomena occur: chronic malfunction situations and increasing depreciation of other functional areas. This is the case of cities such as Calan, Copsa Mica, Calarasi, Zlatna, Otelu Rosu, etc, with an accentuated urban decline, damaging the entire urban structure.

In terms of urban development, it is obvious that such sites require a particular approach: on the one hand, they are *repulsive areas*; on the other hand, they are spaces with multiple use opportunities, resulting either from the association of some functions (residential, recreational, economic) or from their conservation as *urban space reserve*, that could be used for the welfare of the community in the future, when there will be acute pressure on the built-up area. The latter option should be taken into account especially as the general urban plans developed in the cities already show a sprawl tendency of the built-up areas.

4. CONCLUSIONS

In the 60 cities analyzed, brownfields cover surfaces between 6.3 ha (Targu Lapus) and 3497 ha (Rovinari). The 222 inventoried sites range between 0.13 ha and 1137.49 ha.

Brownfield/capita ratio has an average value of 82.13 m²/capita. The highest values are recorded in cities with mining brownfields (Aninoasa - 37.7 m²/capita, Lupeni - 344.6 m²/capita Motru - 353.8 m²/capita, Rovinari - 2656.7 m²/capita).

Urban industrial brownfield/urban green space ratio indicates the unstable situation of many urban environments. Of the total number of cities analyzed, 28 are characterized by greater than one values of this ratio, thus giving them an undesirable label of "gray cities". From this point of view, the worst cases are reported for the mining towns (Motru, Lupeni, Aninoasa Rovinari), where brownfield surface exceeds the green space up to 180 times. An extremely unfavourable situation is typical for cities where UIB / UG ratio is greater than one (e.g. Copsa Mica, Zlatna, Baia Mare) accompanied by carbon black and heavy metal contamination of brownfields. Such brownfields generate problems in terms of land use and population health.

When the polluter pays principle is not applied, numerous brownfields become a chronic problem in terms of environmental quality. On the other hand, the high costs of decontamination discourage local authorities in carrying out this operation.

In terms of spatial distribution of brownfields inside cities, three main distribution patterns have

been identified: mononuclear, bipolar and dispersed. These patterns directly influence the way different functional areas experience constraints derived from proximity situations.

Opportunities associated with the presence of these brownfields are linked, on the one hand, with environmental rehabilitation and, on the other hand, with their inclusion in the urban system by associating several functions corresponding to the needs for development.

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