

## Spatial and Temporal Dynamics of Residential Areas Affected by the Industrial Function in a Post-Communist City – Case Study Bucharest

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### 1 ABSTRACT

Industrial areas are among the main land use categories causing locational conflicts in human settlements. In Romania, this type of problem mainly appeared as a result of the forced industrialization carried out in the communist era (1949 – 1989). In this period, compact, multi-family, high density residential areas were built in order to accommodate the workforce necessary to the large industrial platforms developed in close proximity. As a result, some of the city's residential neighbourhoods were developed in the influence area of the industrial sites, negative side effects being neglected in favour of social and economic benefits. In the post-communist period part of these conflicts disappeared with the reconversion of the industrial units, while others changed their characteristics due to their abandonment. New conflicts emerged between declining industrial activities and residential areas because of the unplanned urban development and increased density of the urban fabric.

The paper is aimed to analyze the changes that occurred in the relationship between the residential and industrial areas during the post-communist era.

In order to fulfil the objectives we created a spatial database containing information about the residential and industrial areas in Bucharest for two different periods. We used spatial analysis, models and scenarios for the analysis. The main findings highlighted the surface decrease of residential areas directly affected by the proximity of industrial function due to the reconversion processes and the emergence of distressed brownfields or abandoned industrial sites (which also have negative externalities on the nearby areas still causing locational conflicts). The main tendency characterizing the dynamics of residential areas is represented by the replacement of individual residential areas with collective residential (blocks of apartments) meanwhile the industrial areas are affected by abandonment, reconversion and relocation. In order to establish the appropriate planning solutions for the future management of industrial areas situated within the urban fabric we studied the reconversion process that took place in Bucharest in the last years and analyzed the advantages and disadvantages of each.

### 2 INTRODUCTION

In 2010, the urban population represented over 50 % of the total world population (UN, Department of Economics and Social Affairs, 2011). Although the surface globally occupied by urban ecosystems is reduced, with only 4 % urban areas with average density over 200 inhabitants/km<sup>2</sup> (Small, 2002), the large population and building concentrations generate challenging problems of system sustainability. Specific fields of research were proposed in order to deal with this phenomenon, such as urban ecology, an interdisciplinary approach aimed at understanding the manner in which the human society interacts with ecological processes in artificial and artificialized systems (Marzhuff et al, 2008).

Urbanisation is increasing through the outward spreading of a city, often non-regulated, and/or infill development inside the city perimeter, leading in either case to the appearance of environmentally inefficient human settlements (Pauleit et al., 2005) and low quality of life. The expansion of built surfaces determines the accentuation of certain problems, such as the pollutants emissions, urban heat island, locational conflicts (such as the industrial – residential association) or the absence of adequate infrastructures.

The association between residential and industrial areas represents one of the most frequent land use conflicts. Industrial sites influence proximity areas with negative externalities such as emissions of pollutants in the air, water and soil, noise due to production and transport activities (Sofer et al, 2012), large quantities

of waste (Lejana & Smith, 2006). Consequently, there is a general decrease in the quality of life, while the health risk increases (Morra, 2009; Marques & Lima, 2011). These consequences were for a long time conscientiously or unconscientiously ignored, as industry is an important factor influencing economic growth, contributing directly and indirectly to the creation of services and sustaining large material, energy, human and information flows between the city and its surrounding environment (Ianos, 1987).

Pre-industrial cities were characterized by a division of urban functions, rather on a vertical than on a horizontal gradient (Chelcea, 2008), with a large incidence of housings situated at the upper floors, above shops, workshops, restaurants and other services. With the appearance of large industrial areas and the intensification of commerce and services, residential areas needed isolated from other functions with negative impact on the quality of life and living. Between 1970 and 1980, most of the cities created a system of exclusive zonation for their different functions (Chelcea, 2008). Although initially industry occupied the peripheral areas of the cities, urban growth determined their physical inclusion inside the settlement. Consequently, the industrial activities, some with high environmental and health impact needed relocation. The industrial relocation to the peripheral areas or satellite cities has certain benefits: lower land prices, permissive environmental regulations and fewer administrative levels of control (Chelcea, 2008).

The relation between residential and industrial areas is a complex one. From the economic efficiency point of view, the production and the residential area need to be in proximity, as it reduces travel time and costs for the workforce. The population searches areas with high quality of the environment, often isolated from industrial sites. The two functions are complementary, but the spatial relation is of mutual exclusion. In order to characterize this complex relation, we can use statistical methods (determining the population exposed or segments of sensible population in industries with high impact upon health), spatial methods (mapping of industrial activities in residential areas (Sofer et al, 2012), mapping and analyzing the patterns of residential segregation (Marcinaczak, 2012)), temporal analysis (diachronic analysis), models, scenarios, interviews and questionnaires (exploring the experience of residents in relation with the industrial activities nearby (Sofar et al, 2012)).

In Romania, the characteristics of this relation have been modified by the transition from the communist and centralized system to a market-based economy. The communist period forced industrialization led to a situation where most of the cities had at least one large industrial unit (even if it was unsustainable, the centralized system ensured its survival for social or even propaganda reasons). The post-communist period determined a decrease in the productivity, extractive and manufacturing industries were closed as the subsidies ceased (Ianos, 2004) and the privatization emerged. If in 1989 the industry represented 58.1 % of the national GDP (Ianos, 2004), in 2011 its contribution decreased to 26.28 % (INS, 2012).

The present study has the purpose of analyzing the manner in which changes from the economic and political system affected the spatial relation between industrial and residential areas from Bucharest. Previous studies realized for this area focused on the historical evolution of the industrial landscape in Bucharest (Mirea, 2012), the reconversion of industrial area (Chelcea, 2008) or the present characteristics of the industrial sector (Cepoiu, 2009).

The objectives of this paper are: 1) to analyze the dynamics of residential surfaces located in the proximity of industrial areas between 1990-2011 in Bucharest, 2) to identify the residential areas currently exposed to negative externalities generated by industrial areas in different stages of reconversion and 3) to develop planning solutions in order to minimize the impact of industrial areas on the residential ones.

### 3 STUDY AREA

Bucharest is the most important political, economic and urban centre of Romania. With a surface of 228 km<sup>2</sup> and a stable population of almost 2 millions inhabitants (INS, 2012), Bucharest is an European metropolis struggling with the environmental and planning problems of large urban areas.

The historical evolution of industrial areas in Bucharest can be differentiated into four main stages: incipient industrialization (until 1918), industrial expansion (1918-1944), communist (1944-1989) and post-communist period (after 1989) or de-industrialization. Each stage had its own environmental and landscape impact, influencing the city as a whole and the residential areas in particular.

The industrial surface in Bucharest has continuously increased (Fig 1) from the beginning of the 20th century, reaching its maximum value in the final period of the communist era (1976-1989),

The industrial activity started with small handcrafting production in the 15th century, in small shops situated generally in the central area of the city, with no separation for the residential areas (Giurescu, 2009). At the beginning of the 20th century in Bucharest 178 industrial units were recorded, with small and non-polluting industries located in the central area and larger ones at that time periphery (now the central ring of the city (fig. 2)). In the industrial expansion period, Bucharest became the most important industrial center in Romania. Since the city developed and increased its spatial footprint, old industrial areas were now comprised within the city, and new residential areas were developed in the proximity of newly created industrial cores (CFR Grivita, Viilor, Titan). Between 1944 and 1989, the communist industrialization led to the development of large compact industrial platforms accompanied by dense residential areas inhabited by the workers (fig.2). The city enclosed in its urban fabric old industrial areas, now with central placement.

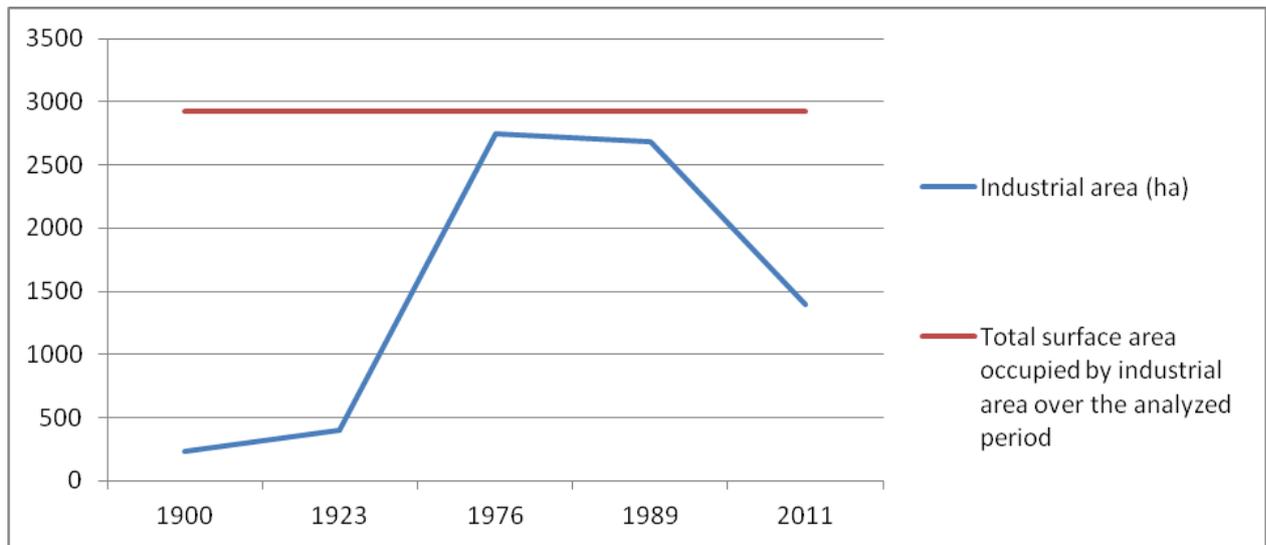


Fig. 1: Dynamics of industrial surfaces (ha) in Bucharest in the last century (after Planul orasului Bucuresti, 1911, 1923; Harti topografice 1977, Ortofotoplanuri, 2008; Mirea, 2012).

Building industrial sites next to residential areas was considered the best solution for eliminating the contrast between central and peripheral districts (Giurescu, 2009) in terms of available public infrastructure, as the industrial activity came together with the necessary transport and public utilities infrastructure. Also, this proximity meant cost and time economies for the workers. In the same time, it generated functional conflicts and discomfort for the residents (exposure to pollutants, noise and odors) overlapped over the insufficiency of green areas and the large proportion of built areas.

The industrial areas encountered in Bucharest in 1989 are very diverse. They include industries with an important negative impact on the environment (~22 % of the industrial areas) such as chemical industry, rubber industry, plastics industry or energy industry, industries with a medium negative impact on the environment (~41 % of the industrial areas) such as machinery industry, transport industry and industries with a low negative impact on the environment (~37 % of the industrial areas in Bucharest) such as food industry or textile industry.

The post-communist era (1989-present) is characterized by the relocation of industrial activities outside the city; process that may generate abandoned distressed brownfields (Dingsdale, 1999), and the reconversion of certain activities. The chaotic development of residential areas due to a lack of legislation represents another phenomenon characterizing Bucharest.

Currently, the residential areas in Bucharest are represented by two main categories: the low density residential (single unit housing or individual residential) which represents 15.15 % of the surface of the city (57.44 % of the surface of residential areas in Bucharest) and the multi-family, medium or highly dense residential areas (multi unit housing or collective residential) which represent 10.26 % of Bucharest surface (38.9 % of the residential areas in Bucharest).

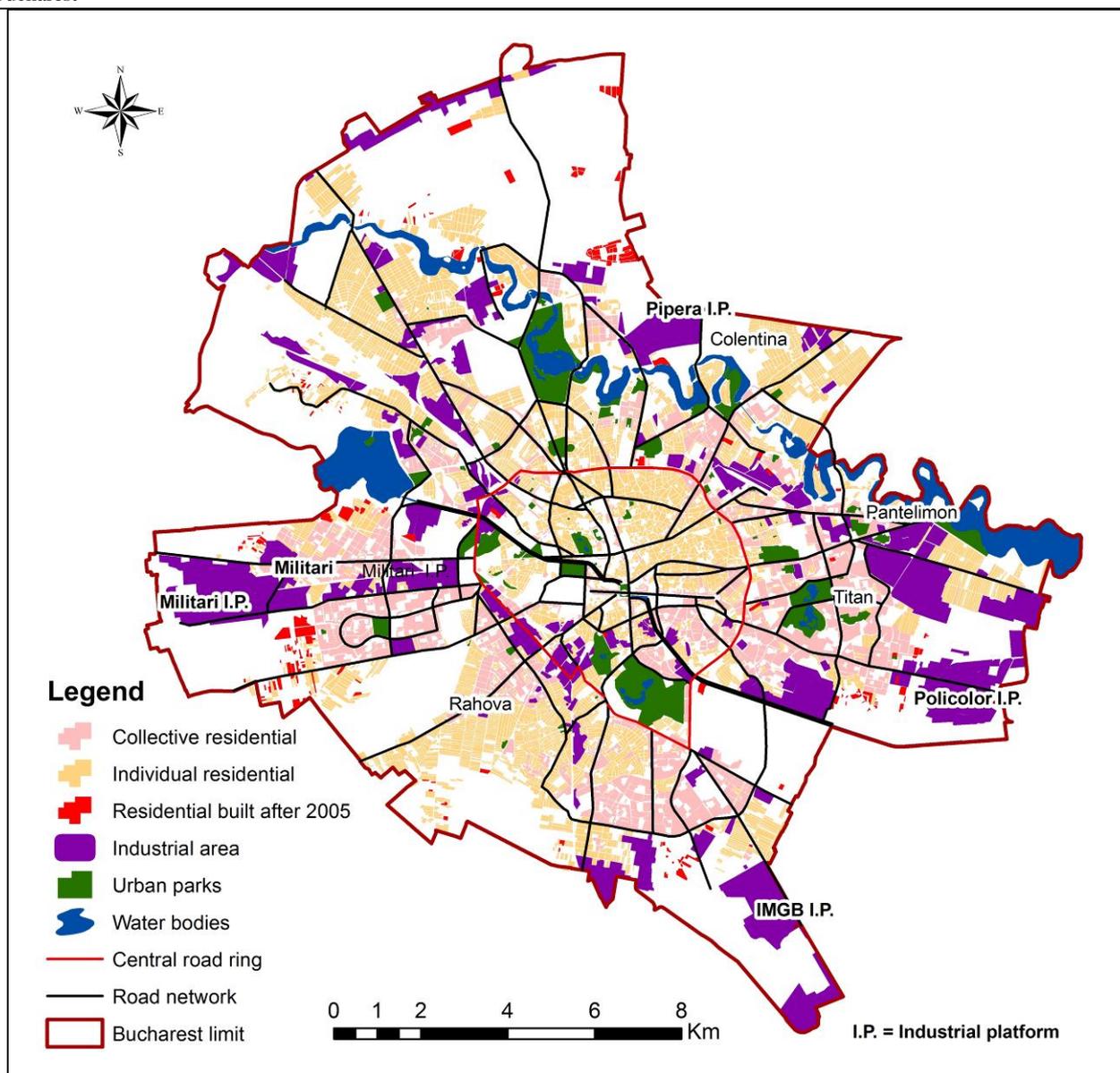


Fig. 2: Residential and industrial area in Bucharest (2011)

#### 4 DATA AND METHODS

In order to assess the spatial and temporal dynamics of the residential areas exposed to industrial function a spatial database was created. The geospatial information was extracted using the 1976 edition of the topographical maps (scale 1:25.000) and 2008 edition of aerial images with an average resolution of 0.5 m ([www.ancpi.ro](http://www.ancpi.ro)). We used as a start point for the analysis the 1976 maps. We considered such an approach is suitable because the large industrial platforms in Bucharest were already built at this point in time and so were the compact, multi-family, high density residential areas which are the main characteristics of this period. We couldn't use satellite images to cover the 1989 moment because even if they permit the differentiation of built and natural areas, the identification of different kinds of functional zones inside an urban area is almost impossible (Chen et al, 2011) being subject of personal interpretation of the urban morphology.

The spatial database contains information about the localization of different categories of residential areas (low density residential areas or individual residential and multi-family medium or high density residential areas or collective residential) and industrial surfaces, their surfaces, the current situation of industrial areas (abandoned or demolished industrial areas, active industrial areas, industrial in conversion and industrial areas affected by improvised conversion) and the main tendency regarding the conversion phenomenon (conversion in residential areas, commercial units, offices building, transportation areas or other uses). The database was validated through field surveys realized in random points.

We used the multiple ring buffer method (a proximity analysis), with an option of excluding the surface of the industrial areas from the resulted buffer (Sumathi et. Al, 2008) for extracting the residential areas situated at certain distances from the industrial areas. For the multiple ring buffers we used the distances mentioned in the Romanian legislation (Order 536/1997) – 300m, 500m and 1000m corresponding to areas strongly, medium and little affected by the industrial function. These distances correspond to the protection areas that should isolate certain industrial activities according to their level of aggressivity in relation with the environment or the human health. Beside the proximity analysis that took into account all industrial areas existing in 1976 and 2011 in Bucharest, for the second moment of interest the analysis was realized also using as input only the still active industrial areas and the abandoned or demolished ones, as these two categories were considered capable to affect in a negative manner the residential located in proximity. The other two identified categories, industrial in conversion and industrial affected by improvised conversion, were considered to have a considerable lower potential of causing problems or discomfort to the nearby residential.

The spatial and temporal dynamics analysis and the modeling of the relation between industrial and residential areas were conducted in ArcGIS 9.3 (Environmental System Research Institute, California, CA) and the statistical analysis was realized in Microsoft Office Excel.

## 5 RESULTS

The residential area in Bucharest represents around 25 % of the city's surface both in 1976 and 2011. The difference is made especially by the change that took place in the structure of the residential, not in its surface. The spatial analysis highlighted that the main process that characterizes the final period of the communist era is the transformation of low density residential areas (individual residential) in multi-family, medium or high density residential areas (collective residential). This process affected about 3 % of Bucharest surface (~15 % of the area occupied by individual residential in 1976 which is considered the start point of the analysis) and resulted in the construction of Rahova (fig. 2) and Crangasi neighborhoods and of the area between Unirii Square and Titan neighborhood.

The figures underline the stagnation of the residential development in the first years of the post-communist period. After 2005 there can be noted a new tendency in the direction of residential areas expansion (~1 % of Bucharest surface is converted to residential uses).

Regarding the industrial areas, their surface increased by 6 % (which means 0.75 % of Bucharest surface) until 2005. That is if we include in this category all the industrial areas (many of them closed, abandoned or demolished) which still kept their image and characteristics until that moment in time. The real conversion process of industrial areas started in Romania after 2005. The spatial analyze, validated through random field surveys, highlighted that the traditionally industrial areas in Bucharest are divided in 4 categories (Mirea, 2012): abandoned and/or demolished industrial areas (12.41 % of the surface occupied by industrial areas in 2005), active industrial areas (47.75 %), industrial in conversion (15.52 %) and industrial affected by improvised conversion (24.3 %) (fig. 6).

In order to evaluate the surfaces of residential areas exposed to the industrial function side effects, a proximity analysis was realized (fig. 3). It highlighted that in 1976 92.57 % of the collective residential areas were located at less than 1000m from an industrial unit (34.94 % within the first 300m, 26.03 % between 300-500m and 31.59 % between 500-1000m) (fig. 4). The percentage was inferior in the case of individual residential – 80.06 % (33.21 % within the first 300m, 18.23 % between 300-500m and 28.6 % between 500-1000m) (fig.5). The situation remains almost the same until 2005 (94.1 % of the collective residential at less than 1000m from an industrial unit (fig. 4) and 79.03 % of the individual residential (fig.5)) with the most important modifications in the surface of the collective residential situated within 300m from an industrial facility. The increase of 5 % is especially due to the construction of Rahova neighborhood in the proximity of Progresului Industrial Platform.

Interesting to notice is that 65 % of the residential built between 2005 and 2011 is also located in the first 1000m from the industrial units (22.27 % at less than 300m, 21.63 % between 300-500m and 21.88 between 500-1000m).

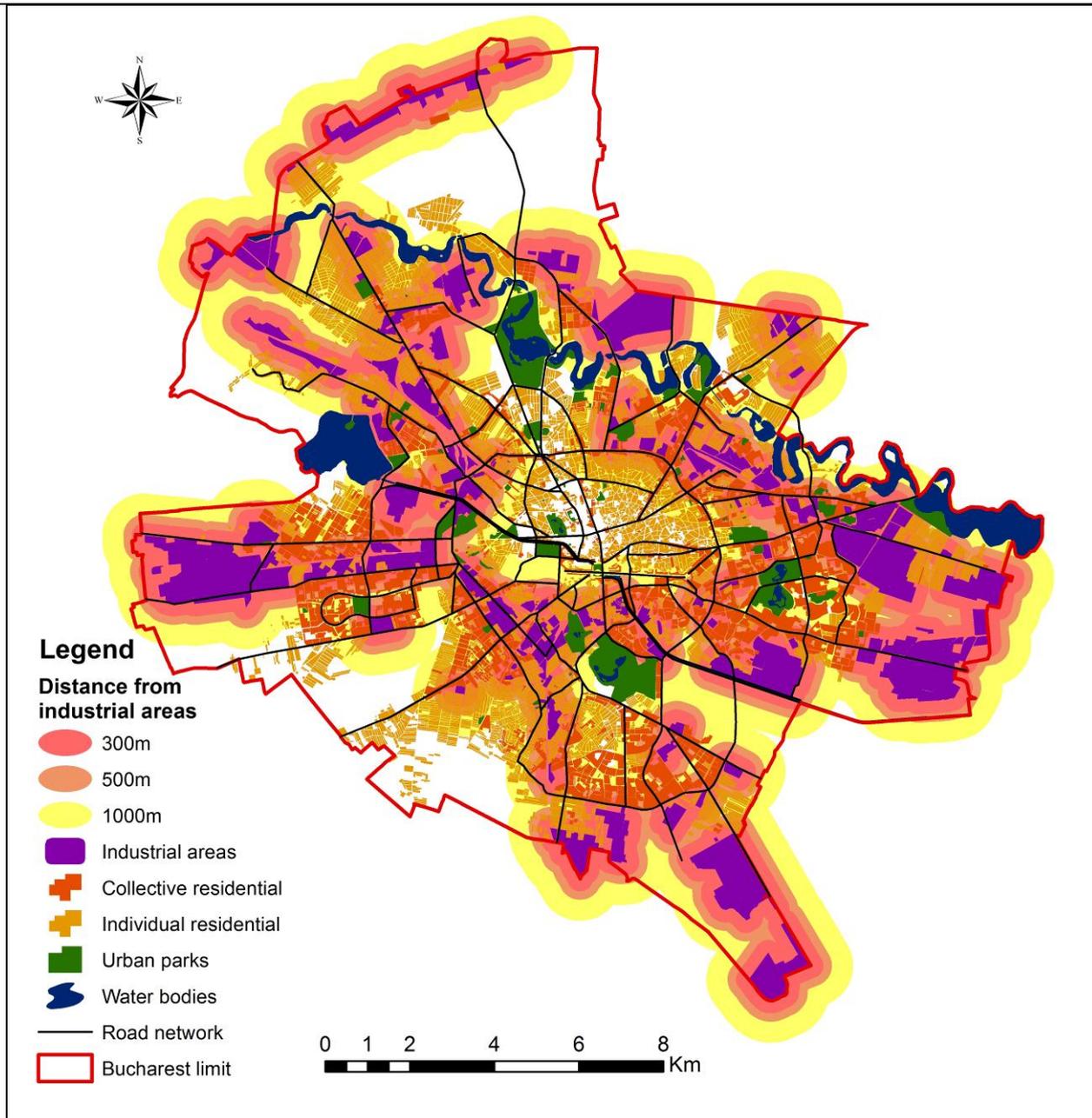


Fig. 3: Distance from industrial areas in Bucharest (including the industrial surfaces which were abandoned, demolished or converted) (2011)

The proximity analysis was also realized for the active industrial areas (fig. 6) and for the abandoned and demolished ones as they were categorized in 2011. Only these two categories of industrial were chosen for the analysis (of the four identified) because these two are the ones which generally cause locational conflicts when situated in the proximity of a residential area. The collective residential areas were exposed in proportion of 57.25 % to the active residential areas (9.46 % in the first 300m) and 51.76 % to the abandoned and demolished ones (14.01 % within the first 300m) (fig. 4). Meanwhile, the individual residential had 40.66 % of its surface affected by active industrial areas (10.58 % within the first 300m) and 51.29 % (12.22 % within the first 300m) by abandoned and demolished industrial sites.

The residential areas built after 2005 have a good localization in relation to the abandoned and demolished industrial areas only small surfaces being in their proximity (2.92 % within the first 300m and 18.32 % within 1000m) but an average one in relation with the active industrial (15.28 % within the first 300m and 54.77 % within 1000m).

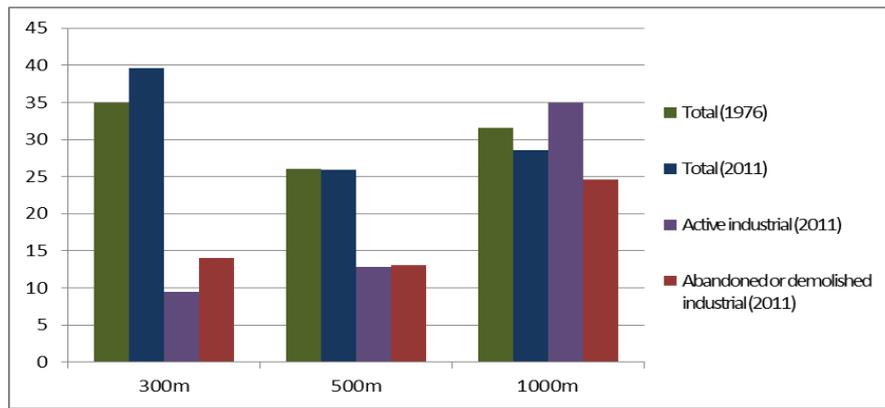


Fig. 4: Percentage of collective residential areas (of the total surface of collective residential in Bucharest) affected by the industrial function

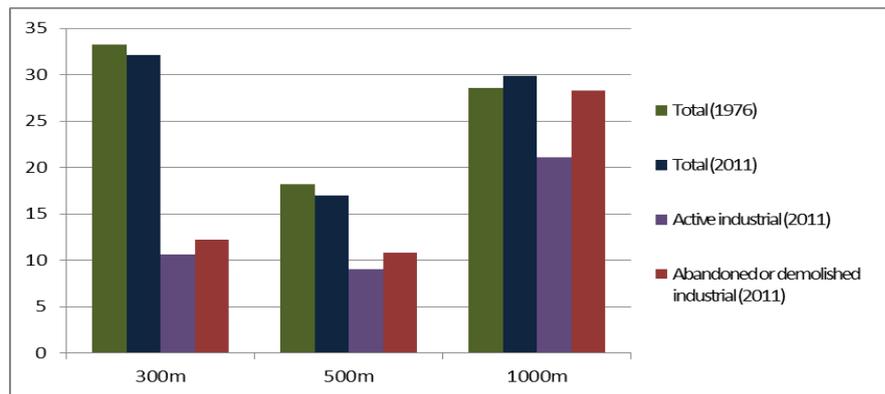


Fig. 5: Percentage of individual residential areas (of the total surface of individual residential in Bucharest) affected by the industrial function

## 6 DISCUSSION

Once the communist era ended and the market-based economy began to replace the centralized system, the expansion of built up areas (both residential and industrial) in Bucharest stagnated. The construction projects left unfinished by the previous regime were partly abandoned and partly finished after years. However, there can be noticed the tendency of ignoring the potential problems that could arise from the vicinity of industrial areas when building new residential.

Regarding the residential areas, the communist era was characterized by the transformation of individual residential areas into collective residential ones and the post-communist era at first by stagnation in construction works, and after 2005 by urban sprawl and infill development.

The reasons that triggered the transformation of individual into collective residential in the communist era were the desire of maximizing the accommodation capacity of the city in order to assure the needed number of workers in a developing economy (Rahova neighborhood was built in the proximity of the industrial units which formed Progresului Platform), the implementation of important planning projects and the desire for improving the quality of life and the image of the city (the construction of Morii Lake which closed the flood protection system of Bucharest led to the disappearance of part of a slum area, while the rest was transformed into multi-family high density residential; the extensive demolition works in the center of Bucharest carried out in order to make room for the House of Parliament were followed by the remodeling of the area and the construction of both administrative and residential buildings).

The dynamics of industrial areas in Bucharest was influenced by the political and economic measures that characterized the first years of post-communism. In those years the industries received important subsidies which helped even the unsustainable ones to continue to function. Slowly, with the subsidies termination, part of the industrial units closed, others were abandoned and some were privatized which in many cases led to the previously mentioned situations. After 2005 the conversion process of industrial areas became an important factor in shaping Bucharest's landscape. With the closure of many industrial units, more than half

(52.25 %) of the industrial area previously existing in Bucharest changed its use. As a direct consequence the residential area affected by this locational conflict almost halved.

Fig. 6 shows that active industrial areas are situated almost entirely in the peripheral areas of Bucharest, the industrial areas near Bucharest central road ring (fig. 2) being abandoned or in conversion. 12.41 % of the ex industrial areas are currently abandoned or demolished, representing brownfields (Oliver et al, 2005). Currently they cause a locational conflict through the negative externalities they produce (PM, odors, noise, historical pollution, feral and stray animals, etc) but better planning solutions may increase the environmental quality in those areas.

Stratton (2000) has identified five directions of the industrial conversion: comercial areas, small and performant industries, residential areas, offices and cultural or retail use. The most used conversion solution in Bucharest appears to be the transformation of previous industrial areas in important comercial facilities (hypermarkets or malls), 35.91 % of the surface of already converted industrial having this function. This surface will increase more once the already approved projects of comercial centres will transform more of the relict land in comercial area. The rest of the industrial surface was converted in offices (38.48 %), residential areas (7.73 %) and other uses (17.84 %). Just a little part of the converted industrial area kept its industrial function and that was possible only due to new approaches such as organizing units for the assembly of different products.

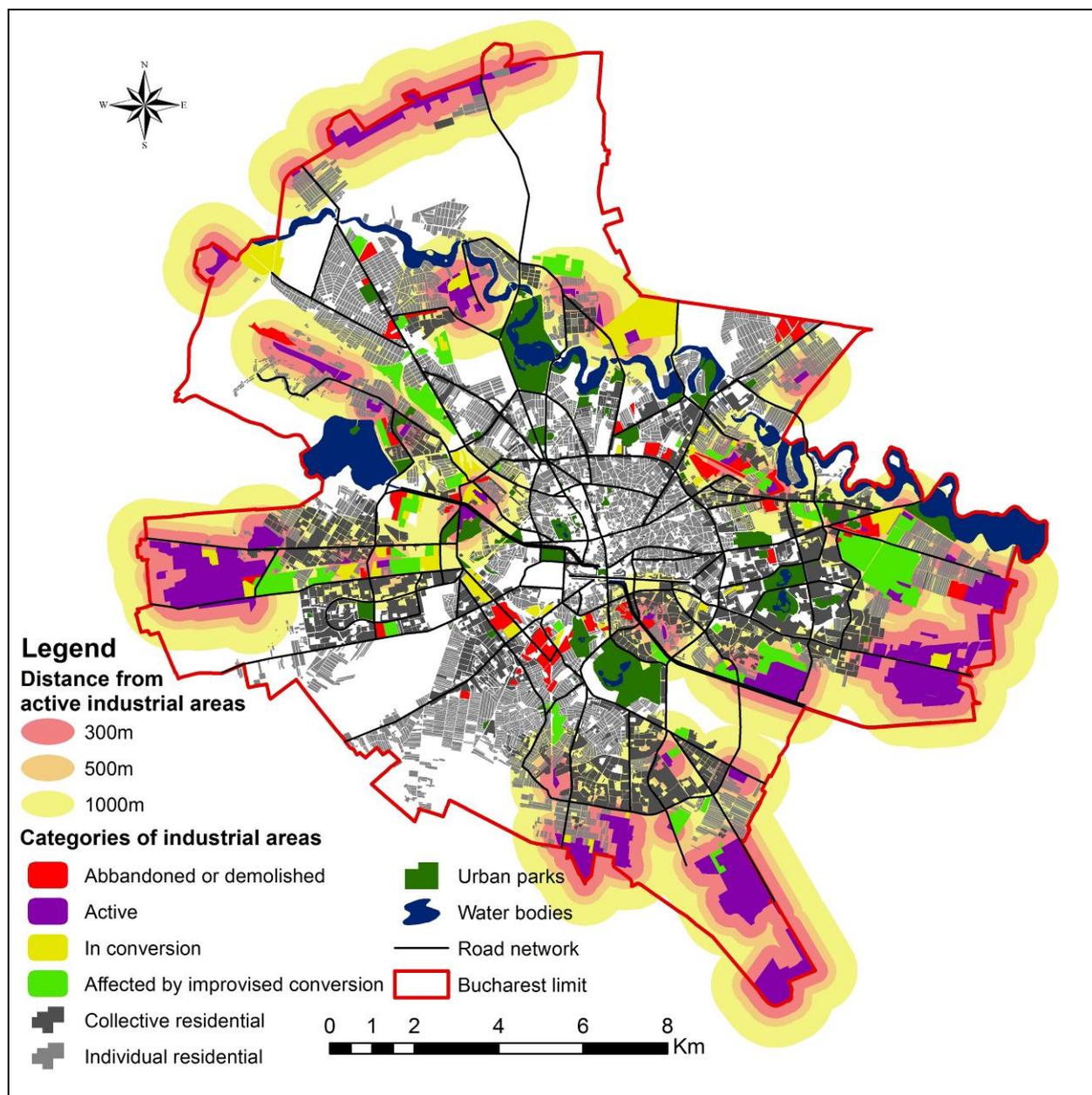


Fig. 6: Categories of industrial areas in Bucharest and the surfaces they affect (2011)

It is important to mention that the distances of 300, 500 and 1000 metres, used in the analysis, were taken from the Romanian legislation. They may vary in other countries and should vary in relation with the magnitude of the negative impact the industrial activity may cause to the environment or human health. Also important is that if an industrial area is separated from a low density residential area by a front of high buildings (offices, collective residential) the latter may not be exposed to the negative impacts the industrial area produces, but the front of high buildings will be affected more. Such an analysis may be the subject of a future research along to the correlation of people's perception of industrial areas and their conversion with the area where they live.

## 7 CONCLUSION

The study area represents a good example of the changes that can occur in a post-communist city with important economic and demographic impact. It offers an example of how a negligent planning (both from an economic point of view and a territorial one) can lead to locational conflicts of high spatial importance. Although currently the surface of residential areas directly exposed to industrial function has decreased, the diversity of locational conflicts caused by the former industrial surfaces has diversified (emergence of abandoned and demolished areas, brownfields, new uses that may still not fit to the proximity of residential areas). A special attention must be directed to the conversion of industrial areas because this process may importantly increase the environmental and life quality in the proximity by promoting projects suitable for each area.

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