

COMPARATIVE CASE STUDY REGARDING THE URBAN EVOLUTION FORM OF THREE EUROPEAN CAPITAL CITIES USING GIS

STUDIUL COMPARATIV PRIVIND EVOLUȚIA URBANĂ A TREI CAPITALE EUROPENE

Adelina NENIU¹, Cristiana VÎLCEA²

Abstract: Urban settlements have always been attractive for the population throughout the history for a better living purposes, working opportunities or even good places for robbery during the wars or migrations. Depending on natural conditions, history or migratory events, cities around the world had known a spectacular evolution over the time, knowing different stages of organized or chaotic growth of their form. Regardless of the population increase registered in the past or the present demographic decline which affects most of the European states, the main cities continued to extend their area. This research presents, in a comparative study, the evolution of three European capitals (Bucharest, Paris and Madrid) in different moments of the history, starting with the 15th century. The study also includes an analysis of the demographic evolution. Using old cartographic resources, recent satellite images and open access databases, the authors analyse the evolution of the form and main directions of urban extension of the three European capitals in relation to the natural conditions and main roads. All data and cartographic resources had been processed and represented using open-source GIS software.

Key-words: *urban evolution, population growth, European cities, Paris, Madrid, Bucharest.*

Cuvinte cheie: *evoluție urbană, creșterea populației, orașe europene, Paris, Madrid, București.*

I. INTRODUCTION

Nowadays cities represent the main living environment. Urban population continues to increase and so do the limits of the cities that tend to consume more of the natural environment and join with other settlements forming metropolitan areas or large urban agglomerations. Big cities, have impressive surfaces, the urban core being extended with suburbs and areas affected by sprawl, which lead to real metropolitan areas which surface and population sometimes triple the one of the actual cities.

The study of urban development had been a subject of interest for many decades, the methods, the interest and the types of studies evolving together with

¹ University of Craiova, Geography Department, email: neniuelina98@gmail.com.

² University of Craiova, Geography Department, email: cristiana.vilcea@edu.ucv.ro (corresponding author).

the cities. The present study is not focused on the recent evolution of Bucharest, Paris and Madrid, but on the extension of these urban settlements from the fifteenth century (although they all had been documented earlier in time) until present days. The selected cities had been the subject of historical or geographical researches that dealt with their evolution (Carmo Ribeiro&Sousa Melo, 2014; Parson, 2003; Barthelemy, 2015), but this research intends to make a comparison between the three settlements.

Previous studies on urban expansion of Bucharest in its early times are relatively few due to lack of documentary evidence, but after 1950, especially from the post-communist period and subsequently, are quite numerous thanks to the development of technology, economy and population growth. One of the works that deals with both the expansion and the population growth is that of the historian Giurescu (1966), which presents the evolution of an early settlement since the time of the Geto-Dacians mentioning the archaeological discoveries that attested the presence of inhabitants in this area until the communist period. Some of his maps representing Bucharest in different periods of time had been used and processed for this study.

1.1. Study area

The study area of the research focuses on three European capitals: Bucharest (Romania), Paris (France) and Madrid (Spain). The three cities were depicted based on their common features regarding the natural environment and their relative central position inside the countries.

The demand of living space and other urban land use that consume lot of space (commercial and industrial spaces, parking lots) caused a rapid and chaotic extension of the urban area in a process known as urban sprawl (Couch et al., 2008). Big cities, especially capitals, had been affected by urban sprawl (Diaz-Pacheco&Garcia-Palomares, 2014; Suditu et al., 2010; Morollon et al., 2016; Aurambout et al., 2018), and the cities in this study case make no exception, but the research concentrates on the evolution of the urban core, without taking into consideration the metropolitan area of the three cities, which is way more extensive.

II. DATA AND METHODS

In order to map the extension of the three city capitals we used old cartographic maps (Table no. 1), satellite images retrieved from USGS and limits of the urban core available in the Urban Atlas retrieved from Copernicus Land. The Urban Atlas is published and made freely available by the European Union. Starting from three simple similarities like the administrative function, the presence of a water body, which influenced the cities form and evolution and the fact that the urban core of the three cities have roughly the same population, the study intends to compare the evolution of the urban form of Bucharest, Paris and Madrid starting with the 15th century.

Table no. 1. Sources used to represent the historical boundaries of the cities

City	Year	Map/ Satellit image	Source
Bucharest	1459	Development of the Bucharest between 1300-1831 (Constantin G. Giurescu)	https://bercenidepoveste.ro/harta-bucurestilor/
	1600	Development of the Bucharest (Constantin G. Giurescu)	https://bercenidepoveste.ro/harta-bucurestilor/
	1700	Development of the Bucharest (Constantin G. Giurescu)	https://bercenidepoveste.ro/harta-bucurestilor/
	1831	Development of the Bucharest (Constantin G. Giurescu)	https://bercenidepoveste.ro/harta-bucurestilor/
	1914	Bucharest city plan after the last official data issued by SOCEC	https://bercenidepoveste.ro/planul-bucurestiului-din-1914-cu-possibilitate-de-download/
	1966	The administrative area of Bucharest (Constantin G. Giurescu)	https://bercenidepoveste.ro/bucurestiul-in-vremea-raioanelor-harta-din-1966/
	2018	Urban Atlas Sentinel 1 satellite images	land.copernicus.eu https://earthexplorer.usgs.gov/
Paris	1646	Septieme plan de la ville de Paris	http://www.oldmapsofparis.com/map/1643
	1721-1744	Le plan de Paris, ses faubourgs et ses environs (Guillaume de L'Isle)	https://www.rijksmuseum.nl/nl/collectie/RP-P-2018-891
	1821	Plan lave topographiquement de la ville de Paris	https://www.davidrumsey.com
	1937	Paris und Umgebung	http://www.oldmapsofparis.com/map/1937
	2018	Urban Atlas Sentinel 1 satellite images	land.copernicus.eu https://earthexplorer.usgs.gov/
Madrid	1656	Mantua Carpetatorum sive Matritum Urbs Regia (Madrid city plan) de Pedro Teixeira Albernaz	https://en.m.wikipedia.org/wiki/File:Pedro_Teixeira_Albernaz_(1656)_Madrid.png
	1762	Old detailed map of Madrid	http://www.vidiani.com/detailed-old-map-of-madrid-city-1762/
	1831	Atlas map of Society for the Diffusion of Useful Knowledge (Great Britain)	https://www.davidrumsey.com
	1950	Madrid-firmamento-1950	https://en.m.wikipedia.org/wiki/
	2018	Urban Atlas Sentinel 1 satellite images	land.copernicus.eu https://earthexplorer.usgs.gov/

Using open-source GIS software, all cartographic resources used had been georeferenced and overlapped before digitizing the limits of the cities in different periods of time. For the administrative limits of the cities in 2018, the authors used the limits found in the Urban Atlas and compared those with the built-up area shown in recent satellite images.

The demographic data had been collected from statistic sites and studies. Old information about population represented a challenge, as old records had not been preserved or kept over time. Not all the time the authors had population records for the same period for all three cities. The parallel between the urban extension and demographics was analysed after 1950. For the city of Bucharest, the demographic data was retrieved from Tempo Online (National Institute of Statistics) after 1992, the Censuses from 1948 and 1966 also provided by the National Institute of Statistics, and for the period before 1940 the data were taken from different sites, but also from the studies of Mitrică et al. (2016) and Szepesi et al. (2011).

III. RESULTS AND DISCUSSIONS

Starting from the similarities and after overlapping the resulted limits from different periods of time we obtained a clear image of the direction and intensity of growth (Fig. 1).

Although the area of Madrid had been occupied since prehistoric times, the settlement was first mentioned in documents in the 10th century. Just like Paris, the Spanish capital had been developed under different occupations (Iberian, Roman, Moors), being mentioned as a fortress. The Madrid city plan drawn by Pedro Teixeira Albernaz and the old detailed map of Madrid from 1762 show the city walls surrounding the castle and part of its gardens. The remains of the old fortress wall are still visible today. Also, the palace and historical events connected to the reconstruction of the residential palace influenced the limits of the city along the time. After Philip II moved the royal court to Madrid in 1561, the seat of the court became the de facto capital. The capital had roughly 20,000 inhabitants by the time and almost 100,000 residents by the end of the 16th century.

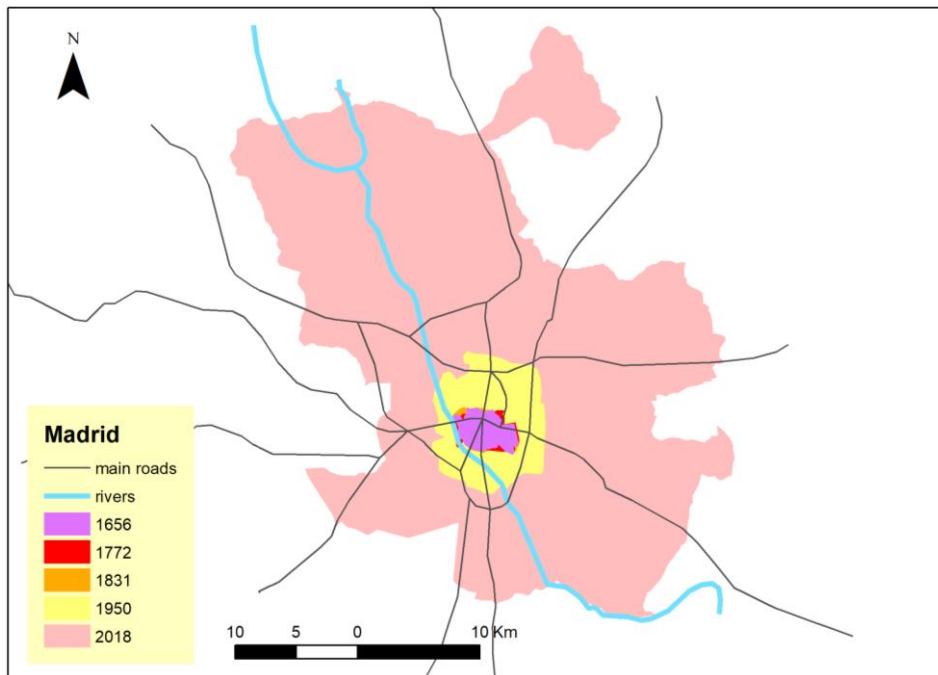


Fig. 1. The urban extension of Madrid between the 16th century and present

From its first official attestation, Madrid developed quickly mostly on the left bank on the river Manzanares, until de the beginning of the 1800, but like most of the large built-up urban areas, Madrid's recent growth (after the II World War) has taken place outside the historic urban core. Also, like many European cities, Madrid's urban core faced a population drop between 1970 and 1990 of approximately 200,000 residents, as people migrated to the suburban areas. Since

1970, the urban area outside the city of Madrid registered almost 98%, in 1990, the suburbs attracted 85% of the population growth, therefore by 2016, the city share of the population had declined to 51%. Thus, the core city of Madrid reached a population of 3,120,000 residents by 1970 and registered only 3,198,000 in 2011 (Table no. 2).

Table no. 2. Population and urban area of Madrid in different periods of time

<i>Year</i>	<i>Population</i>
1897	510,616
1900	540,109
1910	556,958
1920	728,937
1930	863,958
1940	1,096,466
1950	1,527,894
1960	2,177,123
1970	3,120,941
1980	3,158,818
1991	2,909,792
2001	2,938,723
2011	3,198,645
2018	3,223,334

(Source: Instituto Nacional de Estadística / Spanish Statistical Office)

Today the metropolitan area of Madrid is organized administratively into 21 districts subdivided into 131 neighbourhoods and its total population is 6.6 million.

As all the other two capitals, Paris grew steadily, but without any major development until 1831. After this period and especially after the end of World War II, Paris began to develop rapidly, expanding its built-up urban areas (*unité urbaine*), which attracted most of the population growth in the future (Chandler, 1987). The suburbanization process began obvious from the 19th century (Fig. 2). The largest transformation in the urban form and administrative organization of Paris took place during the Napoleon period.

In direct connection with the development of the city, population knew a steady increase until the annexation and administrative reformation which took place between 1856 and 1861. After the annexation, the population from the historical city began its continuous decline. Despite the temporary stagnation due to losses from the First World War, the population reached its highest peak in 1921 (2,906,472 residents) (Table no. 3). The losses of the World War II are noted in the population decline in 1946, while the fastest population growth in the 20th century war registered in 1962 (2,790,091 residents). The following years 1968 and 1972 the population growth is significantly slower as a result of the ending of postwar baby boom period and the end of immigration, while the migration flows from the rest of France become negative.

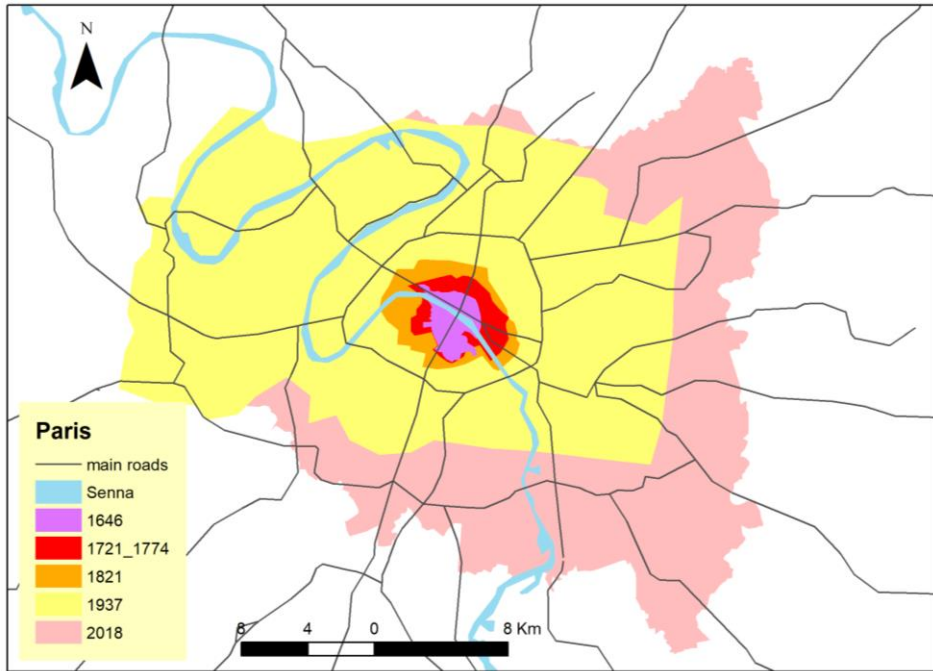


Fig. 2. The urban extension of Paris between the 16th century and present

As for Paris, the metropolitan area has steadily expanded, like Madrid, the latest data (2015) indicating an increase of the population to almost 12.5 million from 10.3 million in 1990. From the entire metropolitan area of 4,440,535 ha only 16% is represented by the core urban area.

Table no. 3. Population and urban area of Madrid in different periods of time

<i>Year</i>	<i>Population</i>	<i>Territorial size (ha)</i>
1285-1314	200,000	400
1422-1461	130,000-150,000	550
1600	300,000	850
1700	490,000	1,450
1785-1792	600,000	3,370
1861	1,700,000	3,370
1900	2,650,00	7,802
1921	2,906,472	
1946	2,725,374	
1962	2,790,091	
1968	2,590,771	
1975	2,299,830	
1990	2,152,423	
2007	2,193,030	
2018	2,211,297	10,500

(Source: Atlas Historique de Paris (<http://paris-atlas-historique.fr>) and the Institut national de la statistique et des études économiques - INSEE)

Bucharest is first mentioned in 1459 in a deed issued during the reign of Vlad the Impaler, but the official documents do not mention what area Bucharest had at that time. The mentions about the population are also absent, as there are no sources to attest this. Constantin Giurescu (1966) made an estimation regarding the extent of the city at the middle of 15th century. The settlement occupied a very small area at that time, being on the left bank of the Dâmbovița, bordered on the north by Lipsani and Ilfov stations, east by Șelari street, and on the right of the Dâmbovița river, the city occupied the meadow (Tătărâm, 1983). Mitrică et al. (2016) estimate for the mentioned period that it had an area of only 15 ha. The second half of the 15th century meant for Bucharest the affirmation as the capital city of the country as it benefited from a significant economic and demographic potential. The following period, during the reign of Mircea Ciobanul (1545-1554, 1558-1559), the city developed mostly in the south, this direction of expansion corresponding to the course of the Dâmbovița and its left bank (Ionașcu et al., 1961). During this period, the city expanded mainly due to population growth and the increase in the number of craftsmen. Bucharest begins to expand to the right of the Dâmbovița, starting with the second half of the 16th century, during the reign of Mircea Ciobanul having at the time an area of about 75 ha, and a population of about 10,000 inhabitants (Table no. 4).

Table no. 4. Population and urban area in different periods of time (Bucharest)

<i>Year</i>	<i>Population</i>	<i>Urban area (ha)</i>
Up to 1595	10,000	75
1600-1650	20,000	190
1700-1789	30,030	285
1800-1831	60,587	1,701
1910-1912	341,321	5,593
1940-1948	1,025,180	6,700
1960-1966	1,336,684	14,300
1992	2,188,461	22,817
2002	2,151,764	23,787
2007	2,158,585	23,787
2011	2,161,874	23,787
2016	2,111,634	-
2018	2,114,236	-

(Source: National Institute of Statistics)

Around 1600, during the reign of Mihai Viteazu, the expansion of the city continued in the southern half reaching 190 ha, from Dealul Lupeștilor to Dealul Văcăreștilor, but the number of inhabitants stagnated during this period. At that time, many of the slums located near the city were included within its administrative limits, where commerce began to develop. Along the time, Bucharest was divided administratively into slums, while the oldest divisions were the parishes. The city is currently divided into sectors. In the second half of the 18th century, Bucharest was considered a large village, which had begun to acquire modern urban aspects. During this period, the surface of the city was only 285 ha. At the end of the 18th century, the population decreased mainly due to the plague,

but the following years it increased considerably, reaching 30,000 inhabitants by the end of the century.

In 1831, the delimitation of Bucharest was made on the basis of the Organic Regulation, and during this period the surface of the city had expanded in all directions, especially in the north and west, covering 1,600 ha, while the number of inhabitants exceeded 60,000. This regulation contributed to the development of Bucharest to a great extent. The period 1830-1910 was marked by a rapid spatial expansion due to numerous historical events and various functions that the city performed: as capital of the Romanian national state, the development of industry and enterprises, trade, modernization of the city, numerous educational units are established; all these propelled the city to an area of over 5,500 ha. The end of the 19th century was marked by a population increase which led to the growth of residential areas. The First World War began in 1914, which meant for Bucharest numerous attacks from Germany and the destruction of several areas of the city, but the surface of the city remained unchanged during this period. The interwar period was marked by new constructions of buildings and state institutions and by a considerable increase in surface that reaches over 7,700 ha, while the population increases in a significant proportion, to approximately 99,900 inhabitants.

The end of the World War II meant for Bucharest the increase of the urban area to over 14,000 ha in 1950, an expansion in all directions and an increase in the number of administrative divisions. In the post-war period, the city's population grew at a slower pace, but only for a short period of time, because in 1948 it exceeded 1 million inhabitants, and, in 1966, it reached approximately 1,330,000. During the communist period Bucharest extended its urban area to 22,000 ha (Fig. 3).

After 2000, the city continued to expand its size, encompassing many of the surrounding rural settlements within the city area, but the city's population declined, reaching a peak in 1992 when it registered over 2,180,000 inhabitants to decrease to approximately 2,110,000 inhabitants in 2018.

IV. CONCLUSIONS

The research may be extended with the study of other European capitals from Central and Eastern Europe or even in the North in the attempt of trying to find out if there are similarities in the urban evolution process and what were the factors that triggered these common aspects.

Bucharest is the example of the capital that has expanded its territory since ancient times, in all directions, at a slower or faster pace, depending on the historical period and the events that triggered the expansion. It experienced a significant growth after the end of the communist period, as it concentrated the most important economic activities of the country, registering numerous systematizations in the residential area and in the suburbs.

The study reveals some common characteristics regarding the urban expansion process and population growth. Until the middle of 19th century the expansion of all cities and the population had a direct proportional increase, while

recent periods brought an extensive urban extension with rapid development of the suburban area, but a decrease in population at a steady, but lower rate.

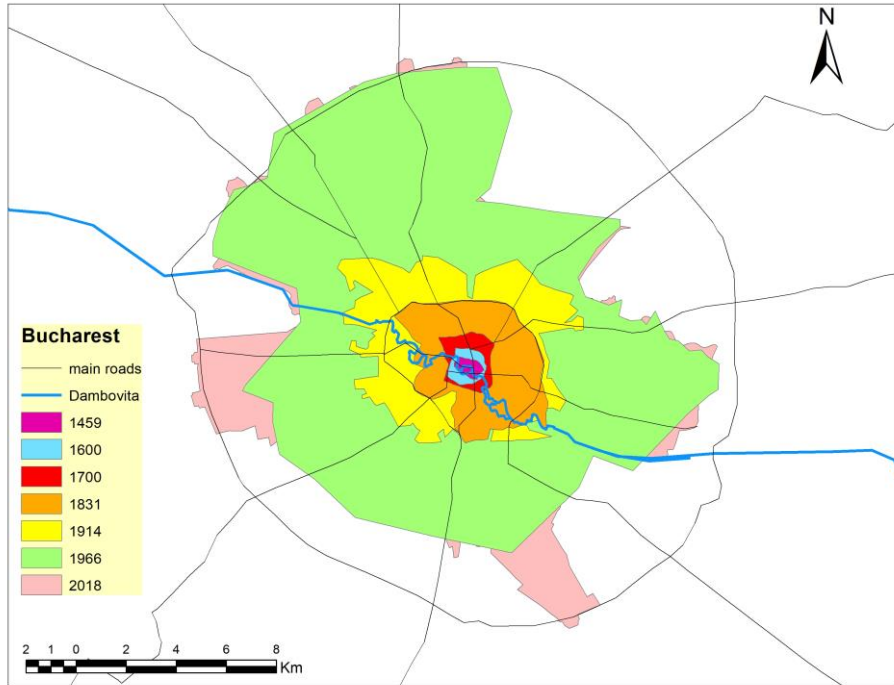


Fig. 3. The urban extension of Bucharest between the 15th century and present

The end of the World Wars, industrialization and modernization caused the development of urban areas and migration of the population toward the cities, but the location within the suburbs. Although, the cities have roughly the same population, core urban area of Madrid (60,430 ha) is significantly higher than that of Paris (10,500 ha) or Bucharest (23,787 ha).

The natural conditions were favourable for the development of early settlements and later modern cities. The presence of the river banks did not obstruct the urban expansion as old bridges linked the river sides and allowed further expansion.

REFERENCES

AURAMBOUT J.-P., BARRANCO R., LAVALLE C. (2018), *Towards a Simpler Characterization of Urban Sprawl across Urban Areas in Europe*. *Land*, 7(1), 33. doi:10.3390/land7010033

BARTHELEMY, M. (2016), *From paths to blocks: New measures for street patterns*. *Environment and Planning B: Urban Analytics and City Science*, 44(2), 256–271. doi:10.1177/0265813515599982

COUCH C., PETSCHER-HELD G., LEONTIDOU L. (2008), *Urban sprawl in Europe: landscape, land-use change and policy*, Wiley-Blackwell; 1st edition

CHANDLER T. (1987), *Four thousand years of urban growth: an historical census*, St. David's University Press, Lewiston, N.Y., U.S.A.

DIAZ-PACHECO J., GARCIA-PALOMARES J.C. (2014), *Urban Sprawl in the Mediterranean Urban Regions in Europe and the Crisis Effect on the Urban Land Development: Madrid as Study Case*. Urban Studies Research, Article ID 807381, <http://dx.doi.org/10.1155/2014/807381>

GHERDEVICH D., NOIZET H. (2014), *Les rythmes spatiaux et temporels de la dynamique urbaine à Paris du 16e au début du 19e s.* MARIA DO CARMO RIBEIRO, ARNALDO SOUSA MELLO. Evolução da paisagem urbana cidade e periferia, pp. 175-204, 978-989-8612-09-0 (halshs-01096147).

GIURESCU C. (1966), *Istoria Bucureștilor: Din cele mai vechi timpuri până în zilele noastre*. Editura pentru literatură, București, 460 p., accesat la adresa <http://www.digibuc.ro/colectii/istoria-bucurestilor-din-cele-mai-vechi-timpuri-pina-in-zilele-noastre-b000269233>

IONAȘCU I., PETRIC A., CARAIOAN P. (1961), *București. Pagini de istorie*. Societatea pentru răspândirea științei și culturii, București, 209 p.

MITRICĂ B., GRIGORESCU I. URUCU V. (2016). *Dezvoltarea urbană și ariile metropolitane în România, natură și societate*. Editura Academiei Române, București, accesat la adresa https://www.researchgate.net/publication/313679886_DEZVOLTAREA_URBANA_SI_ARIILE_METROPOLITANE

PARSON D. (2003), *A Cultural History of Madrid. Modernity and the Urban Spectacle*, Oxford, New York

RUBIERA MOROLLÓN F., PÉREZ RIVERO J., GONZÁLEZ MARROQUIN V. (2016), *Urban sprawl in Spain: differences among cities and causes*, European Planning Studies, 24:1, 207-226, DOI: 10.1080/09654313.2015.1080230

SZEPESI M., SZEPESI A., DUMITRESCU M., CRUCERU N. (2011), *Geografia orașului București*. CD Press, București

SUDITU B., GINAVAR A., MUICĂ A., IORDĂCHESCU C., VÂRDOLC A., GHINEA B. (2010), *Urban sprawl characteristics and typologies in Romania*, Journal of Studies and Research in Human Geography, 4.2, 79-87

TĂTĂRÂM M. (1983), *La margine de București*. Editura Sport-Turism, București

*** *Atlas Historique de Paris* (<http://paris-atlas-historique.fr>)

*** *Institut national de la statistique et des études économiques* (INSEE)

*** *Instituto Nacional de Estadística* (Spanish Statistical Office)

*** Tempo Online, Institutul Național de Statistică, accesat la adresa <http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table>

*** Recensămintele de la 1948, 1956, 1966, 1977, 1992 și 2002 accesat la adresa <https://insse.ro/cms/files/RPL2002INS/vol1/tabele/t01.pdf>