International Journal of Human Settlements Vol. **1** . Nr.**1** . 2017
Are population and its density significant predictors for urbanization? Inconclusive results from Romanian cities over 100,000 during 1990-2012
Alexandru-Ionuț PETRIȘOR
Received: 3 March 2017 • **Revised:** 24 May 2017 • **Accepted:** 31 May 2017

ARE POPULATION AND ITS DENSITY SIGNIFICANT PREDICTORS FOR URBANIZATION? INCONCLUSIVE RESULTS FROM ROMANIAN CITIES OVER 100,000 DURING 1990-2012

Alexandru-Ionuț PETRIȘOR
Associate Professor, Dr, Habil, Ion Mincu University of Architecture and Urban Planning, Bucharest, Romania, e-mail: alexandru.petrisor@uauim.ro

Abstract:
Although the importance of urbanization has been repeatedly stressed out, especially during the adverse ecological consequences resulting from the fragmentation of natural habitats and consequent reduction of their ecosystem services, controversies exist with respect to its magnitude, mechanisms and drivers. This study was aimed at assessing whether population and its density are significant predictors of urbanization. The methodology included geo-statistical analyses carried out in the 25 Romanian cities with a population of at least 100,000 in 1992, for the three periods covered by CORINE data: 1990-2000, 2000-2006 and 2006-2012. The findings suggest on the one hand that only population is a marginally significant predictor for the changes occurred in all the three periods, and that the urbanization rate is better correlated with population and its density than the raw area affected by urbanization. The lack of statistical significance is most likely due to the reduced sample size.

Key words: urban sprawl, correlation, land cover and use, CORINE, real estate boom

Introduction:

The increase of urban population is a fact demonstrated by numerous studies. Nevertheless, its perspective becomes more and more alarming. In 2003, the share was expected to exceed 50% by 2013 (Cohen, 2003); this happened actually in 2008 (Grimm et al., 2008a). Three years later, another study projected a share of 69% by 2050 (Lederbogen et al., 2011). The urbanization process has adverse ecological consequences, as it fragments, simplifies and replaces the adjacent natural and agricultural systems with urban fabric (Luck and Wu, 2002; Poelmans and Van Rompaey, 2009; Petrişor and Sârbu, 2010; Petrişor et al., 2016). These changes affect the green infrastructure, which responds by decreasing the level of ecosystem services (Pauleit et al., 2005; Taylor Lovell and Taylor, 2013; Badiu et al., 2016).

Debates are also present with respect to the causes and forms; the greater political stability determined less land cover and use changes in Western Europe compared to Eastern Europe (Kupková et al., 2013). In fact, the extent of urbanization was hard to assess in Romania, where cities make up only a small fraction of the national territory; the process became visible when the increase was assessed in terms of its share of the urban area (Petrişor, 2012b). Moreover, Eastern-European urbanization occurred though the transformation of agricultural land in the metropolitan areas (Pauchard et al., 2006; Václavík and Rogan, 2009; Grigorescu et al., 2012). Similar findings come form a study of Madrid (Díaz-Palacios-Sisternes et al.,

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND)

2014), distinguishing between three processes: (1) transformation of agricultural land into urban land, (2) development of agriculture and transformation of urban land into agricultural land, and (3) colonization of urban and agricultural land by nature. These results are strengthened by Iaţu and Eva (2016), who show that the abandonment of cropland can be also a precursor of the urbanization process.

Previous studies carried out in Romania pinpointed urbanization as one of the most important transitional dynamics (Ianoş et al., 2011; Petrişor et al., 2010, 2014; Petrişor, 2012a, b, 2015a, b; Popovici et al., 2013). A study by Puşcaşu (2011) indicated four drivers of Romanian urbanization: (1) the expansion of residential housing (second or vacation house) following the abandonment of agriculture; (2) tourism; (3) changes of large cities due to socio-economic drivers; and (4) loss of the traditional rural space and consequent dissolution of borders between urban and rural areas. However, Ianoş et al. (2016) differentiate between the consequence of developing tourism, commercial, and residential facilities between 1990 and 2000, and the metropolitan urban sprawl in the next period.

Divergent opinions exist also with respect to the determinants of urbanization, although authors conceptually agree upon their geographic, socio-economic and demographic nature: area of the city, presence of adjacent urbanized areas, age (date of foundation), topographic heterogeneity, and geographical position (latitude, longitude, altitude) (Aronson et al., 2014), urban population dynamics, water provisioning, transportation, institutional factors, and topography (Shrestha et al., 2012), geographical characteristics, population, income, agriculture GDP, presence of adjacent urbanized areas, and household size (Alig et al., 2004), human socio-demographic changes (Grimm et al., 2008b), GDP, population growth, geographic density, and political and institutional variables (openness and democracy) (Annez et al., 2010), demographic data, investments in capital construction, agricultural and urban output, wage rates in different sectors, foreign direct investments, and rents (Seto and Kaufmann, 2003), population, its density, and economic growth (Güneralp and Seto, 2013), population density, and socio-economic drivers (Ramalho and Hobbs, 2012), population growth and demographic trends, footloose international capital, governance and institutional structures, and agglomeration forces (Seto et al., 2010), or political, economic, and cultural determinants (Fahmi Fikri et al., 2014).

This study aims to see whether population and its density are significant predictors for explaining the urbanization within and around the large Romanian cities during 1990-2012.

Data and methods

The study used CORINE land cover and use changes data, provided free of charge by the European Environment Agency (http://www.eea.europa.eu/data-and-maps/) for 1990-2006 and by the Copernicus Land Monitoring Service (http://land.copernicus.eu/pan-european/corine-land-cover/lcc-2006-2012/view) for 2006-2012 in a shape file format, usable by ArcView/ArcGIS. Since their projection was ETRS 1989 Lambert Azimuthal Equal Area

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND)

L52 M10, it had to be changed unto Stereo 1970 in order to use them and draw the maps. Urbanization was defined as a transformation of agricultural, natural, wetland or water areas in urban areas or urban changes indicating the urban development within the city limits

The cities included in the study were those 25 with a population exceeding 100,000 at the 1992 census (Fig. 1). They were also selected for the geographical consideration represented by an approximately balanced position in the country. Demographic data were obtained from the censuses and statistical yearbooks (National Commission of Statistics, 1993, National Institute of Statistics, 2003, 2007, 2012). The following parameters were computed:

- Average population for each period: defined as the average between the 1992 and 2002 census for the period 1990-2000, between 2002 and 2006 for 2000-2006 and between 2006 and 2011 for 2006-2011. Although the demographic periods do not coincide with those of CORINE data, the closest census data were preferred despite of 1-2 years gaps due to their reliability;
- Density: computed as the ratio between the average population and area of each city. Surfaces were computed using the X-Tools extension of ArcView 3.X;
- Urbanization rate: share of the total area affected by urbanization from the total city area.

The data were processed and analyzed by taking the following steps:

- Clip the data by the administrative contours of cities using the Spatial Analyst extension of ArcView 3.X;
- Define the transitional dynamics and eliminate all others than urbanization;
- Compute the area affected by urbanization for each period and city using the X-Tools extension of ArcView 3.X;
- Intersect the resulting polygons with the administrative territories of cities in order to obtain a database including the city name and surface affected by urbanization within its administrative territory;
- Dissolve the polygons affected by urbanization for each city and period keeping the total area affected as an attribute;
- Compute the correlations using MS Excel 2003 (implementing the formulae for Pearson-Spearman coefficient of linear correlation and its significance).

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND)

International Journal of Human Settlements Vol. **1** . Nr.**1** . 2017
Are population and its density significant predictors for urbanization? Inconclusive results from Romanian cities over 100,000 during 1990-2012
Alexandru-Ionuț PETRIȘOR
Received: 3 March 2017 • **Revised:** 24 May 2017 • **Accepted:** 31 May 2017

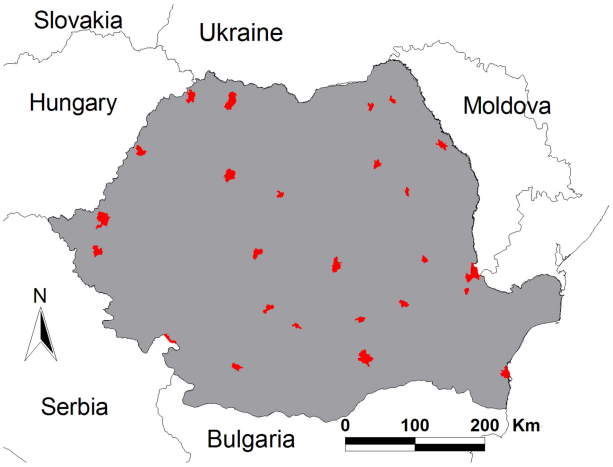

Fig.1. Romanian cities selected in the study: geographical position in Romania and Europe.

Results and discussions:

The results are presented in Table 1. The table displays the value of Pearson-Spearman coefficient of linear correlation and its significance.

Period	Total area affected by urbanization						Urbanization rate					
	Density			Population			Density			Population		
	r	p	n	r	p	n	r	p	n	r	p	n
1990-2000	0.04	0.88	18	0.19	0.44	18	**0.49**	**0.04**	**18**	**0.49**	**0.04**	18
2000-2006	0.06	0.78	24	0.07	0.76	24	0.19	0.37	24	0.08	0.71	24
2006-2012	0.24	0.29	22	0.34	0.12	22	**0.68**	**0.00**	**22**	**0.69**	**0.00**	22
1990-2012	0.12	0.35	64	*0.21*	*0.10*	*64*	**0.38**	**0.00**	**64**	**0.33**	**0.01**	64

Table 1. Correlations between the population and its density and total area affected by urbanization and the urbanization rate within the 25 Romanian cities with a population exceeding 100,000 in 1992. **Bold** values are significant at $\alpha = 0.01$, and Italic values marginally significant at $0.05 < \alpha \leq 0.1$

The results indicate that no significant correlation was found between the population and its density and total area affected by urbanization in any period or overall. However, the overall correlation between the population and area affected by urbanization per city is marginally significant ($0.05 < p \leq 0.1$); this finding suggests that if the sample is extended to include more cities, the results may become significant. The urbanization rates are significantly correlated with population and its density for all periods except for 2000-2006 and overall. Furthermore, the results suggest that urbanization is not necessarily determined by population or its density only, but also by other socio-economic factors, such as the spatial planning and real estate policies, the economic situation etc.; this claim is supported by the fact that, although not significant with respect to the area affected by urbanization, the results from the last period (2006-2012), reflecting the consequences of the 2007 real estate boom (Popa and Giurcă Vasilescu, 2009), approach significance with respect to the area affected by urbanization, and most results related to the urbanization rate are significant.

Conclusion:

The study aimed to test whether population and its density are significant predictors of urbanization in the large Romanian cities. Population was found a marginally significant

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND)

predictor overall. Most likely, the reduced sample size is responsible for not finding statistically significant correlations.

References:

Alig R. J., Kline J. D., Lichtenstein M. (2004), Urbanization on the US landscape: looking ahead in the 21st century, Landscape and Urban Planning **69(2-3):** 219-234.

Annez P., Buckley R., Kalarickal J. (2010), African Urbanization as Flight? Some Policy Implications of Geography, Urban Forum **21(3):** 221-234.

Aronson M. F. J., La Sorte F. A., Nilon C. H., Katti M., Goddard M. A., Lepczyk C. A., Warren P. S., Williams N. S. G., Cilliers S., Clarkson B., Dobbs C., Dolan R., Hedblom M., Klotz S., Louwe Kooijmans J., Kühn I., MacGregor-Fors I., McDonnell M., Mörtberg U., Pyšek P., Siebert S., Sushinsky J., Werner P., Winter M. (2014), A global analysis of the impacts of urbanization on bird and plant diversity reveals key anthropogenic drivers, Proceedings of the Royal Society B **281:** 20133330.

Badiu D. L., Iojă C. I., Pătroescu M., Breuste J., Artmann M., Niţă R. M., Grădinaru S. R., Hossu C. A., Onose D. A. (2016), Is urban green space per capita a valuable target to achieve cities'sustainability goals? Romania as a case study, Ecological Indicators **70:** 53-66.

Cohen J. E. (2003), Human population: The next half century, Science **302(5648):** 1172-1175.

Díaz-Palacios-Sisternes S., Ayuga F., García A. I. (2014), A method for detecting and describing land use transformations: An examination of Madrid's southern urban-rural gradient between 1990 and 2006, Cities **40A:** 99-110.

Fahmi Fikri Z., Hudalah D., Rahayu P., Woltjer, J. (2014), Extended urbanization in small and medium-sized cities: the case of Cirebon Indonesia, Habitat International **42:** 1-10.

Grigorescu I., Mitrică B., Kucsicsa G., Popovici E.-A., Dumitraşcu M., Cuculici R. (2012), Post-communist land use changes related to urban sprawl in the Romanian metropolitan areas, Human Geographies **6(1):** 35-46.

Grimm N. B., Faeth S. H., Golubiewski N. E., Redman C. L., Wu J., Bai X., Briggs J. M. (2008a), Global change and the ecology of cities, Science **319(5864):** 756-760.

Grimm N. B., Foster D., Groffman P., Morgan Grove J., Hopkinson C. S., Nadelhoffer6 K. J., Pataki D. E., Peters D. P. C. (2008b), The changing landscape: ecosystem responses to urbanization and pollution across climatic and societal gradients, Frontiers in Ecology and the Environment **6(5):** 264-272.

Güneralp B., Seto K. C. (2013), Futures of global urban expansion: uncertainties and implications for biodiversity conservation, Environmental Research Letters **8(1):** 014025.

Ianoş I., Petrişor A.-I., Stoica I. V., Sârbu C. N., Zamfir D., Cercleux A. L. (2011), The different consuming of primary eco-energies and their degradation in territorial systems, Carpathian Journal of Earth and Environmental Sciences **6(2):** 251-260.

Ianoş I., Sîrodoev I., Pascariu G., Henebry G. (2016), Divergent patterns of built-up urban space growth following post-socialist changes, Urban Studies **53(15):** 3172-3188.

Iaţu C., Eva M. (2016), Spatial profile of the evolution of urban sprawl pressure on the surroundings of Romanian cities (2000-2013), Carpathian Journal of Earth And Environmental Sciences **11(1):** 79-88.

Kupková L., Bičík I., Najman J. (2013), Land Cover Changes along the Iron Curtain 1990-2006, Geografie **118(2):** 95-115.

Lederbogen F., Kirsch P., Haddad L., Streit F., Tost H., Schuch P., Wüst S., Pruessner J. C., Rietschel M., **Deuschle M., Meyer-Lindenberg A.-M.** (2011), City living and urban upbringing affect neural social stress processing in humans, Nature **474(7352):** 498-501.

Luck M., Wu J. (2002), A gradient analysis of urban landscape pattern: a case study from the Phoenix metropolitan region, Arizona, USA, Landscape Ecology **17(4):** 327-339.

National Commission of Statistics (1993), Census of population and houses on January 7, 1992: general results, population, households, houses [in Romanian], National Commission of Statistics, Bucharest, Romania.

National Institute of Statistics (2003), The census of population and housing of 2002, National Institute of Statistics, Bucharest, Romania.

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND)

National Institute of Statistics (2007), The national statistical yearbook, National Institute of Statistics, Bucharest, Romania.

National Institute of Statistics (2012), The census of population and housing of 2011, National Institute of Statistics, Bucharest, Romania.

Pauchard A., Aguayo M., Peña, Urrutia R. (2006), *Multiple effects of urbanization on the biodiversity of developing countries: The case of a fast-growing metropolitan area (Concepción, Chile)*, Biological Conservation **127(3):** 272-281.

Pauleit S., Ennos R., Golding Y. (2005), *Modeling the environmental impacts of urban land use and land cover change - a study in Merseyside, UK*, Landscape and Urban Planning **71(2-4):** 295-310.

Petrişor A.-I. (2012a), *Dynamics of the environmental transformation processes during 1990-2006 in Romania reflected by land cover and use changes*, Present Environment and Sustainable Development **6(1):** 353-365.

Petrişor A.-I. (2012b), *Land cover and land use analysis of urban growth in Romania*, Human Geographies **6(1):** 47-51.

Petrişor A.-I. (2015a), *Land cover and land use changes reflecting the environmental impacts of declining economies. Case study: south-west development region, Romania*, Romanian Journal of Geography **59(1):** 29-39.

Petrişor A.-I. (2015b), *Using CORINE data to look at deforestation in Romania: Distribution & possible consequences*, Urbanism Architecture Constructions **6(1):** 83-90.

Petrişor A.-I. Andronache I. C., Petrişor L. E., Ciobotaru A. M., Peptenatu D. (2016), *Assessing the fragmentation of the green infrastructure in Romanian cities using fractal models and numerical taxonomy*, Procedia Environmental Sciences **32:** 110-123.

Petrişor A.-I., Grigorovschi M., Meiță V., Simion-Melinte C. P. (2014), *Long-term environmental changes analysis using CORINE data*, Environmental Engineering and Management Journal **13(4):** 847-860.

Petrişor A.-I., Ianoş I., Tălângă C. (2010), *Land cover and use changes focused on the urbanization processes in Romania*, Environmental Engineering and Management Journal **9(6):** 765-771.

Petrişor A.-I., Sârbu C. N. (2010), *Dynamics of geodiversity and eco-diversity in territorial systems*, Journal of Urban and Regional Analysis **2(1):** 61-70.

Petrişor A.-I., Sârbu C. N. (2010), *Dynamics of geodiversity and eco-diversity in territorial systems*, Journal of Urban and Regional Analysis **2(1):** 61-70.

Poelmans L., Van Rompaey A. (2009), *Detecting and modelling spatial patterns of urban sprawl in highly fragmented areas: A case study in the Flanders-Brussels region*, Landscape and Urban Planning **93(1):** 10-19.

Popa A., Giurcă Vasilescu L. (2009), *The real estate investments and the financial crisis in Romania*, Finance - Challenges of the Future **10:** 65-70.

Puşcaşu V. (2011), *Some considerations about urban planning and urban landscape relationship in Romania*, Public Administration & Regional Studies **4(1):** 50-60.

Ramalho C. E., Hobbs R. J. (2012), *Time for a change: dynamic urban ecology*, Trends in Ecology and Evolution **27(3):** 179-188

Seto K. C., Kaufmann R. K. (2003), *Modeling the drivers of urban land use change in the Pearl River Delta, China: Integrating remote sensing with socioeconomic data*, Land Economics **79(1):** 106-121.

Seto K. C., Sánchez-Rodríguez R., Fragkias M. (2010), *The new geography of contemporary urbanization and the environment*, Annual Review of Environment and Resources **35:** 167-194.

Shrestha M. K., York A. M., Boone C. G., Zhang S. (2012), *Land fragmentation due to rapid urbanization in the Phoenix Metropolitan Area: Analyzing the spatiotemporal patterns and drivers*, Applied Geography **32(2):** 522-531.

Taylor Lovell S., Taylor J. R. (2013), *Supplying urban ecosystem services through multifunctional green infrastructure in the United States*, Landscape Ecology **28(8):** 1447-1463.

Václavík T., Rogan J. (2009), *Identifying Trends in Land Use/Land Cover Changes in the Context of Post-Socialist Transformation in Central Europe: A Case Study of the Greater Olomouc Region, Czech Republic*, GIScience & Remote Sensing **46(1):** 54-76.

Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License (CC BY-NC-ND)