

# Ecological Footprint of the Population on Croplands and Sustainable Development of Small Towns in Bucharest Metropolitan Area - Case Study<sup>1</sup>

Elena Matei

University of Bucharest, Faculty of Geography, 1 N. Balcescu Avenue, 010041, Bucharest, Romania  
e-mail: matei@geo.unibuc.ro

## Abstract

*The aim of this study is to apply and develop the analysis of cropland ecological footprint of the population to demonstrate that the knowledge of it can help to draw a sustainable development strategy, of the administrative units. The study tries to shape the population pressure in situ or remote, by calculating the cropland ecological imprint, just to analyze the interaction between natural capital values and population demands, taking as case studies several small towns, around the largest urban centre of Romania, Bucharest, which were its food pools for a long time. The results obtained show that the population increased due to the development of real-estate projects, while production remained constant, fact which creates heavy pressure on the environment. The land biocapacity capitalizes the power of an area in comparison with the cropland imprint of population and helps the sustainability of actions at the local level. At the same time, by adding other indicators it can configure the consumer's features and thus it can build the local capacity for self-sustaining, avoiding the trend of agglutination to the urban metropolitan model.*

**Keywords:** *small towns, metropolitan area, Bucharest, ecological imprint, sustainable development*

**JEL Classification:** *Q56, Q21, O18*

## Introduction

The end of the 20th century and the beginning of 21st century are characterized by the tendency to increase the space occupied by the urban habitat. How this happens varies from one region to another, from one country to another. Thus, in many countries (e.g. India) with a low percentage of urban population it is observed a trend of concentration in urban conurbations (Mookherjee, Debnath, Hoerauf, E., 2004). Others as Germany, Japan, France continue to increase the polarization process and consequently the urban population proportion (Kratka, S., 2007). Romania enrolls in the specific processes of Eastern Europe, namely the creation of new urban spaces by transforming rural settlements into small towns and by the development of big cities

---

<sup>1</sup> A preliminary result of the paper was orally presented at Deva, at the Romanian Symposium of Geography, but the paper has not been published. The study derived from the CNCSIS Grant, No 292/2007, "Socio-economic development of Romanian small towns, between potential and communities demand."

to the stage of metropolization, with slight decentralization processes as a result of market economy.

In Romania, the urban growth can be in conjunction or not with the dynamics of small towns. Thus, the trend of dispersal that is seen as a dystrophy of the mechanism in the build-up area of the cities or as a different response to economic, social and environmental issues, can supply the viability of small towns located in nearby areas. In this way, it is noticed an increase in the role of towns in the suburbs not only for the function of living, but for tertiary activities as well. On the other side, lack of jobs in small towns has stimulated a permanent or temporary displacement of residents to the big agglomerations and thus led to the extinction of some urban features.

In this era of transformation of the major urban centres, the role of the small towns has returned as a debate topic. Peter Calthorpe (1993), one of the greatest architects of these decades, admitted that “small towns that have been recognized and promoted as features of collective life provide an alternative for micro-urbanism”.

Studies about the trends of urbanization cover a great diversity and are of interest for many scientific fields, starting with their functionality up to the urban policies, from the community's expectations to their involvement in decision-making. Of course, an important role is played by the urban top to bottom policy management, but many of their successes are rooted in their past experience, and also in the studies from the administrative framework level of each municipal entity. One of the researchers' tests is to calculate the population imprint in order to estimate more accurately the human pressure on the environment.

Starting from regional development paradigms, in order to analyse the population imprint we must consider the location theory, both economically and geographically. Since the beginning of the 19th century, it was formulated the location theory based on transport costs, in correlation with distance and area (Thünen, 1826, quoted by Antonescu, Daniela, 2003), which is currently an available theory, due to the computational of both land prices and agricultural use, in relation to a settlement. The deterministic points of view in geography and economics still mark the economy's location, price formation, (Launhart, 1887, Papay Emese<sup>2</sup>, 2007) and the choice of the place for living. The role of natural factors in location is decreasing due to the modernization and development of transport and consequently, the labour mobility, employment, investments and the emergence of attractors in: research and training, low transaction costs, cheap labour etc. Iancu (2005<sup>3</sup>) enlarges their importance in shaping the poles or centres of attraction (Perroux, Fr. 1973).

Together with these issues and in close contact with them, in the recent years, a special attention has also been paid to the environmental issues of the urban settlements: the pressure on the resources, the waste, the quality of life etc. A major concern regards the Earth capacity to support the continuously increasing demands in resources and particularly the way in which the urban centres deal with this problem. That is why several questions became leitmotiv during the 20th and 21st centuries, especially in global policies: How much will we use? How much can be cultivated and grazed? How long can we use this potential? How does the flow of resources work in this process of huge urbanization?

---

<sup>2</sup> PhD thesis: *Perfecționarea calculației costurilor prin metode moderne*, 2007, ASE, Bucuresti, pp. 241-243.

<sup>3</sup> Iancu, A., *Industrii strategice, criteriile de determinare și politici de susținere a acestora, Creșterea economică, ocuparea și competitivitatea în economia bazată pe cunoaștere*, Program: CEEX 05-08-no. 24/05.10.2005.

In fact, the basic idea of this problem is not new; it has roots in the Rome Club debates, Malthusian theory, carrying capacity (Meadows 1972, Ehrlich 1982, Tiezzi, 1984, 1996, Brown and Kane 1994) and the sustainable development (Brundtland Rapport, 1987).

Because, the general tendency is to reach the Western model of life, which gradually became a global aspiration, many institutions try to find out methods and techniques to measure and appreciate the sustainability. Thus, by applying calculation methods developed by Mathis Wackernagel, William Rees (University of British Columbia), in 1990, UNEP, UNDP, World Bank have an instrument to analyze the society demands versus the environment offer. It is about ecological imprint which measures how much land and water claims the man to produce resources and absorb waste, using widespread technology. Applying the ecological footprint methodology, the nowadays population would need 3.5 planets Earth, according to the economic fabric and the current land use ([www.ecologicalfootprint.com](http://www.ecologicalfootprint.com)).

Taking into consideration these achievements and limits concerning the difficulties of calculating the ecological footprint at the local level, the study tries to analyze the changes of ecological cropland footprint patterns of the towns situated around Bucharest, in combination with the location of footprint for providing goods.

The hypothesis of the study: Are the small towns, which have farmlands, capable to use their bio capacities or, faced with the increase in population and positioned close to the hypermarkets services, did they change the model of consumption similarly with that of the big cities compromising their sustainable development?

## **Methods of Research**

Although at the global level there has been developed a series of methods and techniques for calculating the ecological footprint of the population, in this study, ecological footprint was designed to identify only consumption of crop plants, without taking into account the output of waste in the ecosystems, as Wackernagel's model does (Wackernagel and colab.1999), in comparison with the local capacity of the biosphere in a reference year-2008. The investigation is based on an extensive process oriented on three directions: the population demand in crop plant on a chosen territorial entity; biocapacity; the origin of the offer and supply of commercial items in order to establish the probable geographical location of ecological cropland footprint of these towns.

The methodology for estimating the ecological cropland footprint of people at the community level has involved three main steps. The first step consisted of identifying a common set of indicators based on quantitative analysis (statistics) taken from the National Institute of Statistics and small town mayoralities' data. The second step was to carry out structured interviews among people in order to establish predictive models for public consumption, applying the same questions, followed by selection and comparison of common keywords, based on qualitative research, in order to shape the location of footprint inside town, country or regions. The third step was the estimation of ecological cropland footprint of chosen towns.

To estimate local human pressure by eating food that covers vital needs, it takes into account a number of indicators that creates an image of generally agricultural use. In this sense, by the results obtained through the processing raw data from the NIS, anthropogenic pressure is estimated by agricultural density of population (number of people versus the area of arable land), intensity of use of lands (percentage of arable land in the total cropland area of an administrative unit) and the cropland offer per capita.

There followed the assessment of average consumption by means of the values obtained by extrapolating the data on population consumption (NIS) with those extracted from structured interviews applied on June 2, 2008 and November 2, 2009 on five subjects of each sample, two

land owners and three non-land owners, regarding the consumption via supermarkets and the correlation of these results with the below adapted formulae, used to estimate the cropland footprint of population (1):

$$Ecf = \sum \frac{C}{Gp} \times 100 \tag{1}$$

and Ewing methods (2<sup>4</sup>):

$$Ecf = \frac{C}{Gp} \times Yf \times Eqf \tag{2}$$

$$B = A \times Yf \times Eqf/P$$

## Results and Discussions

Modelling ecological footprint is not recommended locally, due to the difficulty in assessing the total input which exceeds the administrative unit, fact for which the current study is especially focused on those calculable elements to reveal the pressure's location at the local, national and international levels and which demonstrates the influence of the ecological footprint model of Bucharest city. Using the above methods and methodology, the results reveal many interesting facts.

Density of population on agricultural land expresses the offer of arable land and space per capita, whose values denote the recent agricultural functions of these localities. Therefore, for small towns around Bucharest that have been recently promoted from rural areas and that functioned as agricultural plant pools for the capital markets, population density varies between 1 pers. / ha up to a maximum of 18 pers. / ha, which induces the preservation of their past functions (table 1). Except for Chitila town, all others are similar to rural values. But, in terms of the individual share of agricultural land or agricultural area per capita, (Table 1, last column), the averages of these towns are below the world standard, about 0.64 ha per capita, which prefigures the values of ecological cropland footprint.

**Table 1.** Intensity of land-use in agriculture

Town	Land-use intensity (%)	Arable (%)	Density (capita/ha)	Ha/capita
Bragadiru	74.02	97.46	5	0.20
Buftea	46.77	97.66	8	0.12
Bolintin V.	54.21	97.92	5	0.20
Chitila	59.89	91.61	18	0.06
Fundulea	84.83	97.50	1	1.30
Magurele	76.28	96.49	2	0,44
Mihaiesti	76.87	97.05	1	0.72
Otopeni	63.28	96.84	5	0.19
Popesti L.	86.76	91.49	3	0.33
Pantelimon	38.36	95.19	7	0.15

Source: NIS

<sup>4</sup> Ecf-Ecological footprint; C - consumption (t), Gp - Global production (t); B - Biocapacity, A - area (ha); Yf - yield factor (National Footprint network) for 2008 was 1.5; Eqf-equivalent factor 2.64 (*Ibidem*); results are expressed in global hectares (Gha); P = population.

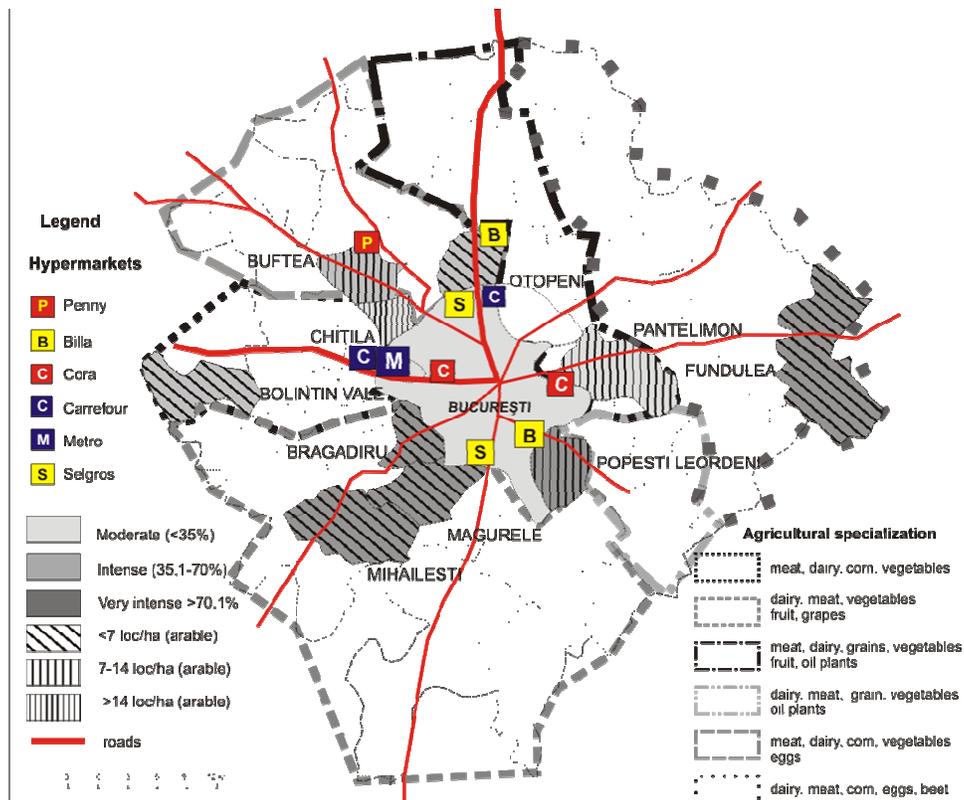
From this point of view only Fundulea and Mihailesti towns, agricultural areas essentially, have a superior offer, so that global production can satisfy, theoretically, the needs of the local population.

The intensity of land-use demonstrates that all these towns use their maximum potential for agricultural purposes, except for Buftea and Pantelimon, towns where agricultural land is included rapidly in built-up area that enlarges the population number (fig.1.). Thus, the last two examples tend to reach critical mass of housing, becoming close to the urban tissue model of Bucharest. Several similar situations are to be found in Popesti Leordeni and Bragadiru, recently declared as urban centres (2004, 2005) where farm land is sold by landowners for real-estate projects.

The results of the interviews underline that the people's habits, living in blocks of flats, are to equally use both formal local commercial services (1/3) and those from outside, respectively Bucharest's hypermarkets (1/3) with some products of the local (in)formal markets namely products offered by people with agricultural property (1/3), (table 2).

For the land owners respondents, the prevalence of their own food in consumption is clear (2/3), except in winter when they accept the local commercial services and those of supermarkets, to purchase either tropical food or processed products (oil, sugar and bread), (1/3).

Studying the range of products sold for food consumption by hypermarkets in towns and nearby Bucharest, especially the most accessible and attractive (Figure 1), it has been elaborated a model ecological imprint spreading.



**Fig. 1.** The intensity of farmland use, agriculture specialization (Ilfov Council data) and accessibility to the hypermarket services

The Great Commercial Association Network of Romania commissioned a market study which shows that most merchandises in the hypermarkets are provided by import, because of the high cost of domestic production and the seasonality of products. The fruit market is dominated (75%) by Netherlands, Chile and China, the vegetables by Turkey and Holland (85%) (The Financial newspaper, November 26, 2006). If we expand the information on meat market, it is up to 10% from EU imports (crude meat) and 85% for frozen products. Processed food of daily importance comes from import, too (35%). Using some extraction operations the consumer footprint can be estimated. Thus, taking some examples from the AMRCR market study on the hypermarkets merchandise's provenience and the responses of local people regarding estimations on quantities consumed by individual, there were two types of footprints in terms of its projection at local, national, global level, namely that of the population without property with an almost equal impact on local level and abroad and that of the owners with bigger impact on local environment (Figure 2).

The obtained matrix shows the tendency to increase consumption of vital food supplies via hypermarket services in those towns which have registered an increase in population and built-up areas such as Buftea, Otopeni, Chitila, Popesti Leordeni, where the consumer's profile is almost similar with that of any inhabitant from Bucharest, whose ecological footprint is located in other regions and less in local area (Table 2).

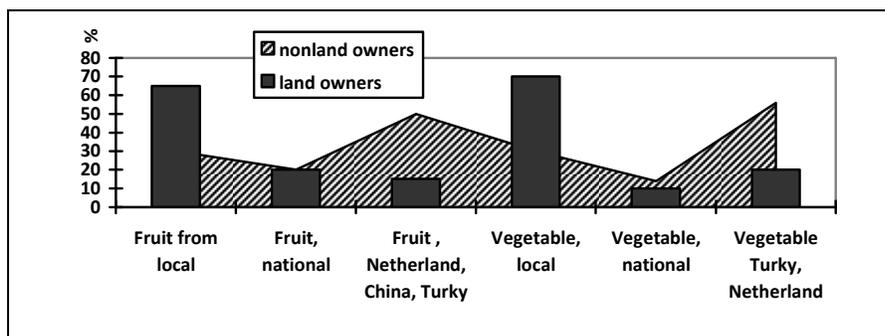


Fig. 2. Geographical projection of the consumers' footprint

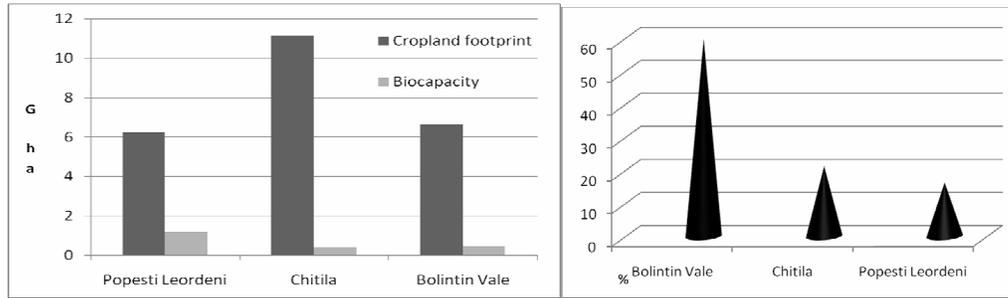
Table 2. The orientation of the interviewed persons on food demand supplies

Town	Local owner	Non-owner	Local resources (%)		Hypermarket (%)		Local store (%)	
Bragadiru	2	3	80	35	7	20	13	45
Buftea	2	3	70	25	15	45	15	30
Bolintin Vale	2	3	80	35	5	15	15	50
Chitila	2	3	75	10	10	80	15	10
Fundulea	2	3	85	70	1	5	14	15
Magurele	2	3	75	30	12	30	13	40
Mihailesti	2	3	80	70	5	5	15	25
Otopeni	2	3	60	20	15	55	25	25
Popesti L.	2	3	70	35	10	30	20	35
Pantelimon	2	3	70	35	10	45	20	20
<b>Sum Average</b>	<b>20</b>	<b>30</b>	<b>74.5</b>	<b>36.5</b>	<b>9</b>	<b>33</b>	<b>16.5</b>	<b>29.5</b>

Note: Based on the interviews applied on 2 June and 2 November, 2009.

The cropland footprint is appreciated through the Ewing model (2008) and as percent of consumption needs of population and the production in selected towns: Bolintin Vale, Chitila and Popesti Leordeni. Calculations show that the consumption is higher than the production as it was planned (Figure 3). But, applying the Ewing model, further, the study reveals a low biocapacity which is not used in its entire potential. The cropland footprint in each selected areas is almost equal with Romania's (1.5).

Even if the wheat crop, plant that has the highest values of the planted area, production covers only 50% of the population needs (Bolintin Vale).



**Fig. 3.** Biocapacity and cropland footprint in Gha (method 2-B). The wheat footprint of population (method 1-A)

The ecological footprint is not the magic tool to analyze the sustainability, but it helps to appreciate several dimensions: e.g. biocapacity and consumption model having limits and advantages.

Although there are limitations in the accuracy of assessment, because only the cropland footprint is calculated, one can argue that relatively low values of cropland footprints can be linked to the consumption pattern of urban population centered on meat products. In this context, two sustainable measures are recommended, respectively to focus on farming development by increasing the yields using organic farming, extending the land reclamation and encouraging the ecological diets for people.

Thus, the present study, although there are some limitations to the accuracy assessment, because it only calculates the footprint of land under cultivation, and has not assessed the type of diet, mainly vegetarian, carnivore, but only a mixed one, has the advantage of offering a diverse methodology for estimations which can give a realistic picture of the relationship between potential and requirements of these communities.

In this context, some sustainable measures have to be taken, such as: raising efficiency in agriculture, intensively and/or extensively, by implementing organic farming and encouraging the ecological diet of the population.

## Conclusions

Therefore, the method chosen only elucidates some aspects of the relationship between population consumption and bio-capacity, the current pressure on resources in order to take corrective measures in the long term. The variety of approach and results in this study helps to outline the commercial services and indirectly the diet structure.

Results show that land is used below its bio-capacity, given the soil fertility of the Romanian Plain, and it is the local authorities' duty to remove the land that lies fallow and organize farms to increase the yield for each crop, including crop rotation, irrigation and organic fertilization.

In addition, the present study suggests daily food market upgrading, modernizing and fostering the weekly fair trade, just as the local agendas of those cities have provided some objectives.

## References

1. Allen, E., *Measuring the New Urbanism with Community Indicators*, AICP, Portland, Criterion Planners, Engineers, 1997.
2. Boboc, Șt., *Cercetarea structurii consumului alimentar in țara noastră*, Editura ASE, Bucuresti, 1982.
3. Boyden, S. et al., *The ecology of a city and its people: the case of Hong Kong*, University Press, Canberra, 1981.
4. Charevet, J.P., Sivignon, M., *Géographie umaine. Question et enjeux du monde contemporain*, Armand Colis, Paris, 2002.
5. Dachin, A., Structura consumului alimentar în România – o expresie a sărăciei, în “*Aderarea României la Uniunea Europeană – bătălia cu timpul*”, Editura Economică, Bucuresti, 2004.
6. Duțu, M., *Ecologie. Filosofia naturală a vieții*, Editura Economică, București. 1999.
7. Ewing, B. et al., *Ecological Footprint Atlas*, Global footprint network, 2008, p. 6-10.
8. Humă, C., Dumitru, C., *Aspecte globale ale ecologizării urbane și implicații asupra calității vieții*, Revista Calitatea Vieții, vol. XIV, no. 1/ 2003, pag. 1-16.
9. Katz, P., *The New Urbanism. Toward an Architecture of Community*, McGraw-Hill Professional Publishing, 1993.
10. Krätke, S., Metropolization of the European economic territory as a consequence of increasing specialization of urban agglomerations on the knowledge economy, *European Planning Studies*, Vol. 15, No. 1, 2007.
11. Mărginean, I., Bălașa, A., *Calitatea vieții în România*, Editura Expert, București, 2002.
12. Martin Bang, *Ecovillage-A Practical guide to Sustainable Communities*, Bath Press, UK, 2005.
13. Mookherjee, D., Hoerauf, E., Cities in transition: monitoring growth Trends in Delhi urban agglomeration 1991 – 2001, *Dela 21 Journal* 2004, p. 195-203.
14. Perroux, Fr., *Pouvoir et économie*, Dunod, France, 1973.
15. Rojanschi, V. et al., *Cuantificarea dezvoltării durabile*, Editura Economică, București, 2006.
16. Sfințescu, C., *Pentru București. Noi studii urbanistice. Delimitări, zonificare, circulație, estetică*, Institutul de Arte Grafice „Bucovina”, 1933.
17. [www.scribd.com/doc/15626650/The-Ecological-Footprint-Atlas-2008-A-Pegada-Ecologica](http://www.scribd.com/doc/15626650/The-Ecological-Footprint-Atlas-2008-A-Pegada-Ecologica)
18. \*\*\* *The Financial Newspaper*, November 26, 2006
19. \*\*\* INS (2007) Fișele localităților.
20. \*\*\* Popești Leordeni-PUG 2007.
21. \*\*\* Chitila-PUG 2007.
22. \*\*\* Bolintin Vale-PUG.
23. \*\*\* Ilfov Council, Planul de Amenajare a Teritoriului din Județul Ilfov, 2004-2008.

## Amprenta ecologică a populației asupra terenurilor arabile în orașele mici din aria metropolitană București - studiu de caz

### Rezumat

*Scopul prezentului studiu este de a aplica și dezvolta analiza amprentei ecologice alimentare a populației, cu scopul de a demonstra că prin cunoașterea acesteia se poate jalona traiectoria unei dezvoltări durabile, pe unități administrative. Studiul modelează presiunea populației asupra mediului apropiat sau mai îndepărtat, prin calcularea amprentei ecologice a populației asupra terenurilor arabile cultivate, pentru a pune în evidență jocul dintre oferta unui spațiu și cerințele comunității sale, luând ca studii de caz orașele mici din jurul celui mai mare centru urban din România – București - care au*

*constituit multă vreme bazine agricole pentru capitală. Rezultatele obținute demonstrează că în condițiile creșterii populației din aceste orașe pe seama proiectelor imobiliare și a producției agricole relativ constante, se asistă la apariția unor presiuni în mediu. Biocapacitatea capitalizează puterea unui teritoriu în raport cu amprenta ecologică a populației, ajutând - prin cunoașterea ei - la configurarea strategiilor de dezvoltare durabilă. În același timp, prin abordarea altor indicatori, se pot stabili trăsăturile consumului și astfel să se dimensioneze capacitatea de autosusținere locală, pentru a elimina tendința de aglutinare spre modelul de viață metropolitan.*