

THE SPATIAL CHANGES OF LAND USE IN THE BUCHAREST METROPOLITAN AREA 1970s – 2000s

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Abstract: The article explore the dimension of spatial changes of land use in the Bucharest Metropolitan Area (BMA) over the past forty years. Using GIS-based land use data sets of the years 1970, 1990 and 2000, combining with statistical data, we attempted to quantify the spatial pattern of land use changes in the BMA. Our findings indicate that most significantly changes occurred with arable lands that have been reduced from 77% percent of total metropolitan area in 1970 to 71.3% in 2000 and in same time the built up area increase from 6.2% in 1970 to 10.4% in 2000. Vineyards and orchards suffered a reduced of their spread. In the case of vineyards the percentage of total area decrease from 2.7% in 1970 to 0.8% and regarding orchards from 1.1% in 1970 to 0.6% in 2000. The growth of built up indicate the urban influence of Bucharest city on it the large metropolitan area. The decrease of vineyards and orchards can be correlated with agrarian reform passed after the fall of socialist economic system that generated many problems for the farmers that cannot continue to cultivate the land with these kinds of cultures. These findings have implication with the futures strategies on urban and metropolitan planning in this area.

Key words: Urban landscapes, Bucharest metropolitan area, Land use/cover, Spatial changes.

Introduction

In the last decade, Romanian geographers provided in their studies an exceptionally attention for Bucharest metropolitan area (BMA). This fact is underlined by a various PhD thesis which analysed this area from different points of view. We mention here the contribution of Ioja (2006) and Grigorescu (2010) that studied the quality and human impact on the environment, the natural and artificial hazardous; Cepoiu (2009) had described the spatial distribution of industrial activities after the fall of socialist economic system; Nae (2009) and Suditu (2005) followed the changes of the quality of housing and life; Gherasim(2007) using cartographic data

sources designated the spatial evolution of Bucharest and how it is reflected from the oldest maps to today.

Land use and landscape changes in the urban areas are the topics analysed in many scientific articles. Most of them are based on using satellite images, aerial photographs, topographical maps and statistical data (Zhang et al., 2003; Eetvelde, Antrop, 2004; Keys et al. 2007). Landscape metrics are calculated to describe the spatio-temporal changes in land use and land cover (Jiet. Al., 200; Braessler, Klotz, 2006; Palmer, 2004).

The spatial changes of land use, particularly to agricultural land in the rural-urban fringe, were schematically portrayed by Bryant et al. (1982). He recognised the existence of four 'zones' around a big city. The first is inner fringe were much of the land was converted to constructions or has planning

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permission. Secondly, the 'outer fringe' is characterized by rural land-uses, although there is infiltration of urban-oriented elements as single family dwelling along routeways. Together, the inner fringe and outer fringe can be extended up to six or ten miles from the edge of the city. The third zone is urban shadow, where the urban influence is minimal, but is presence of non-farm residence and the non-farm ownership of land. The fourth zone is rural hinterland where the metropolitan influence does not stop and are present different items such as second homes.

This article describes land transformation in BMA since 1970 and the impact of those transformations on the urban structure. As in others metropolitan areas, we expect the growth of residential land use and this is recognized being very important for economic and ecological planning (Keys et al., 2007: 131). In this article we explore from what and to what land uses changed. We evaluate first in terms of urban development and what type of land were converted and where are located these area. Second we evaluated the impact of agrarian reforms passed after the fall of communist system that changed the use of agricultural land.

Study area

The Bucharest, Romania, metropolitan area consists of the city of Bucharest and other ninety-four municipalities. This is the area approved by the City hall of Bucharest in 2005, although does it not recognised as an administrative units by Romanian Government or National Institute of Statistics to provide data centralised at this level. The BMA occupied partially or completely 5 counties (Ilfov 100%, Călărași 35.3%, Giurgiu 27.9%, Dâmbovița 5.7%, Ialomița 1.5%). Spatial borders of BMA are corresponding approximately with the limits or rural-urban fringe, at a circle radius of 50-60 Km, but it could reach 70 Km in the south-eastern extreme region (Figure 1). Plăcintescu et al.

(2005: 3) in a study about this area state that it is:

„astructure absolutely necessary for sustainable development and harmoniously of the country capital and its neighbourhood communities”.

BMA in the whole has fertile agricultural lands or lands that can be used for residential, commercial and industrial. The relief of the region is represented by the Romanian Plain, with the maximum altitude of 137.5 m in the north-east. The mean annual temperature is 11°C and the average quantity of precipitation is 500-550 mm per year.

Bucharest City is the largest Romanian city, with a population around 2 million people. The population of metropolitan area is about 564.000 in 2002. The map of spatial distribution of population in BMA reveal a concentration of population nearly Bucharest and the Oltenița town. Lesser amount of population is distributed in the south-eastern part of BMA, corresponding with the large lakes of the Mostiștea Plain. Bucharest City is characterized by a strong hypertrophy, which is influencing the proximity region. This facts is best underlined by the absence of the big cities on a circus of nearly 200 Km, excepted Ploiești City. In the metropolitan area, close to Bucharest, are small cities, passed as cities during socialist time or immediately after 1990. These cities are today dynamic urban centers, with a continuous expansion and urban attraction. We mention here Otopeni town, located at 17 Km far from Bucharest, where is found International Airport 'Henri Coandă', a town that attract diverse economic activities as commerce and services. In these conditions agriculture is losing its contribution in local economy.

Analyzing the today dynamic of the Bucharest City indicate that it is at the second urban life cycle called *suburbanization* in the sense of spatial deconcentration, which represents 'the moment of apparition and intensifications of the relations between Bucharest as a metropolis and its metropolitan area' (Plăcintescu et al., 2005: 9).

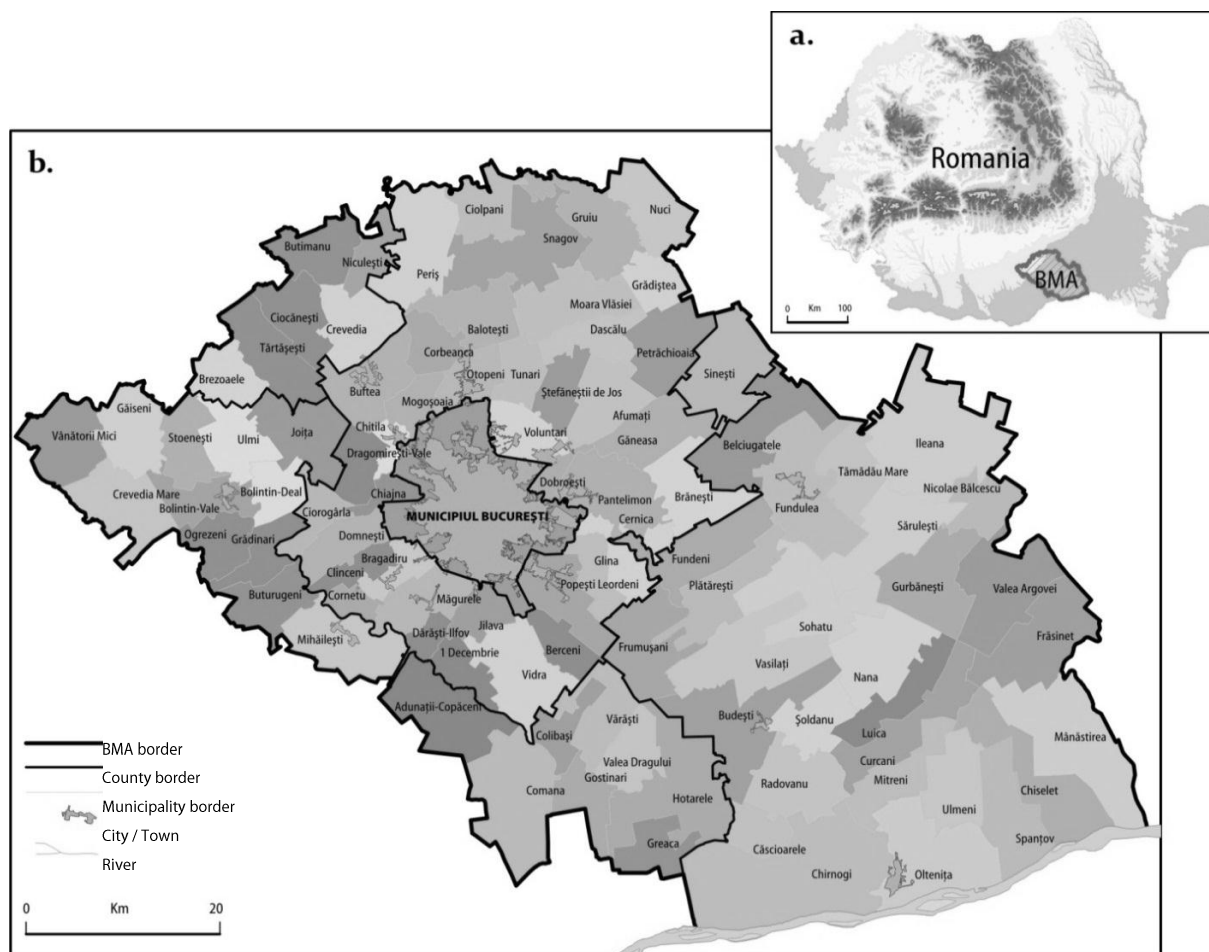


Figure 1. a. Location of the study area in Romania.
 b. Administrative map of the study area

The development of the country capital and the metropolitan municipalities is spontaneous and uncontrolled and longer without a large strategy to development this area, with modifications of the master plans which being correlated with these spatial evolutions.

After the fall of communist system one of the major driving forces that influenced rural and urban spaces of the metropolitan area was represented by the transition to market economy, based on the private investments in the whole economics sectors. Placed the investment in metropolitan area, nearly Bucharest, was stimulated by the low-priced of available lands, cheap labor market and fiscal facilities. Whole of these created an wave of urban deconcentration of industrial and services activities, that where relocated and expected in the suburban area, because are contributed at diversification of the local economy and increase the population wages and city hall budgets.

Materials and Methods

Land use data are derived from the analysis of topographical maps for the 1970, a time series of Landsat satellite images from years 1988 and 2000, and the CORINE Land Cover (CLC) maps for the 1990 and 2000. The topographical maps (1: 50,000 scale) were scanned and georeferenced using ArcView GIS version 3.2a, to allow map overlay with CLC maps and easy compression. In order to compare the data from these different sources we generated a common classification system in ten classes (Table 1) and calculated the area and percentage for each class in total area. To calculate trajectories, such as Keys et al. (2007: 135) we used 1970 as the base year for comparisons with subsequent years. To compare some of the results base on topomaps and CLC maps we used the data provided by National Institute of Statistics collected at the municipalities' level and we assembled them at the metropolitan level.

Table 1. New classification system for comparing CORINE LC and topographic maps land cover/land use classes

CORINE LC classes		New land use/cover classes for CLC & topomap
1. Artificial surfaces		
1.1. Urban fabric	1.1.1. Continuous urban fabric 1.1.2. Discontinuous urban fabric	1. Built-up areas
1.2. Industrial, commercial and transport units	1.2.1. Industrial or commercial units 1.2.2. Road and rail networks and associated land 1.2.3. Port areas 1.2.4. Airports 1.3.1. Mineral extraction sites	
1.3. Mine, dump and construction sites	1.3.2. Dump sites 1.3.3. Construction sites	
1.4. Artificial, non-agricultural vegetated areas	1.4.1. Green urban areas 1.4.2. Port and leisure facilities	
2. Agricultural areas		
2.1. Arable land	2.1.1. Non-irrigated arable land	3. Arable lands
	2.1.2. Permanently irrigated land	
	2.1.3. Rice fields	4. Rice fields
2.2. Permanent crops	2.2.1. Vineyards	5. Vineyards
	2.2.2. Fruit trees and berry plantations	6. Orchards
2.3. Pastures	2.3.1. Pastures	7. Pastures
2.4. Heterogeneous agricultural areas	2.4.2. Complex cultivation patterns 2.4.3. Land principally occupied by agriculture, with significant areas of natural vegetation	3. Arable lands
3. Forest and semi-natural areas		
3.1. Forests	3.1.1. Broad-leaved forest	8. Forests
3.2. Scrub and/or herbaceous associations	3.2.1. Natural grassland	7. Pastures
	3.2.4. Transitional woodland-scrub	8. Forest
3.3. Open spaces with little or no vegetation	3.3.1. Beaches, dunes, sands	9. Beaches, dunes, sands
4. Wetlands		
4.1. Inland wetlands	4.1.1. Inland marshes	10. Water bodies
5. Water bodies		
5.1. Inland waters	5.1.1. Water courses	10. Water bodies
	5.1.2. Water bodies	

Results

Throughout the period analysed here, the predominantly land use was represented by arable land, which took shares in the total metropolitan area of 77% (on the topographic map of the '70s), 70.5% and 71.3% (on the CLC map 1990, respectively 2000) (Table 2).

The second place in terms of land use in this hierarchy was taken by forests that occupied on the 70s a 9.9% share of the total metropolitan area. CLC maps from 1990 and 2000, count the share of forests almost the same, being 10% for both period. Instead, the share of land occupied by artificial surfaces (urban fabric, industrial, commercial, transport

Tabel 2. Land use/cover data

	Topomap 1970	CORINE LC 1990	1970/ 1990	CORINE LC 2000	1990/ 2000
1 Built-up areas %	6,2	10,3	+66,1	10,4	+1,0
2 Urban green spaces and recreations sites%	0,2	0,3	+79,7	0,3	No change
3 Arable lands %	77	70,5	-8,4	71,3	+1,1
4 Rice fields %	-	0,8	-	0,1	-87,5
5 Vineyards %	2,7	0,9	-66,0	0,8	-11,1
6 Orchards %	1,1	0,6	-45,3	0,6	No change
7 Pastures %	-	2,9	-	2,8	-3,4
8 Forests %	9,9	10	+1,4	10	No change
9 Beaches, dunes, sands %	0,1	0,1	+38,7	0,1	No change
10 Water bodies %	3	3,6	+20	3,6	No change

Source: Author's calculations

units, mine and construction sites) in 2000 we found an increase of about 66% compared with the 70s. Currently, we expected that their presence is even higher, because the majority of real estate projects began to be finished after 2000 (particularly after 2003). Areas occupied by water bodies registered a slight increase from 3% in 70s to 3.6% in 2000, without any changes between the interval 1990-2000.

We have not conclusive data about pastures. Identifying their extension on topographical maps was not possible. On the CLC we calculated a ratio of 2.9% pastures of total metropolitan area in 1990 and 2.8% in 2000. A very high level reduction is represented by vineyards, which share of total metropolitan areas decrease from 2.7% in 70s to 0.8% in 2000. This means is a significant decline of about 66% in almost 30 years. Fruit trees and berry plantations also reduced to half in the same time units, from a share of 1.1% to 0.6%. The less percentages were held by artificial, non-agricultural vegetated areas (green urban areas and sport and leisure facilities) which held a share of 0.2% in 70s and 0.3% in 2000, and in the same time the area with inland marshes and dunes have been stagnant (0.1% of total metropolitan area) and rice fields decrease from 0.8% in 1990 at 0.1% in 2000.

Land use map in 1970

Topographical maps at 1:50,000 scales, from the early '70s, showed us predominance of arable land through entire Bucharest metropolitan area (figure 2). Others land uses classes somewhat reduced, almost in the form of "patches" were represented by forests areas, settlements and large vineyards spread on the south-western part of the metropolitan area, in a region named by Romanian geographers Neajlov Plain. Also, there were quite evident lakes on the Dâmbovița Valley, near Bucharest, Snagov Lake area and Comana pool. Analysis of data collected from the topographical maps at the counties within the metropolitan area or for Bucharest city suggest different situation from one county to another.

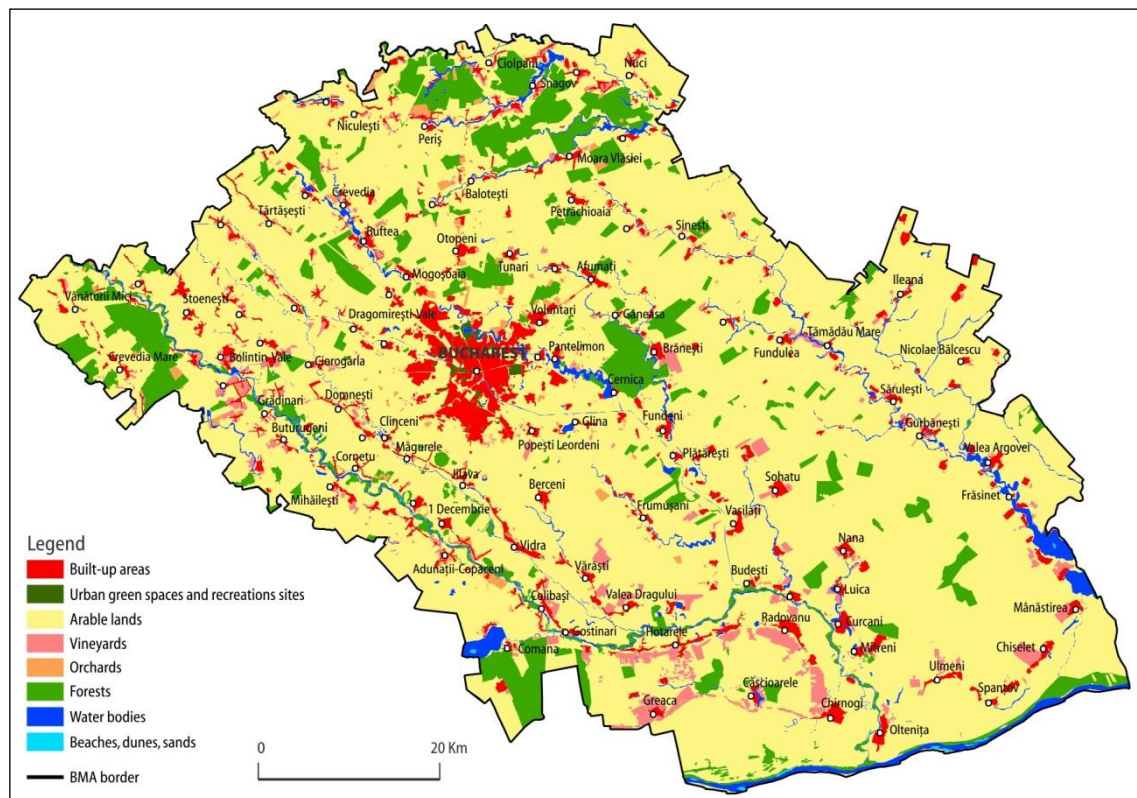


Figure 2. Land use/cover map for 1970

The largest share of continuous and discontinuous urban fabric (built-up class) was in Bucharest (36.4% of total city area), while in other county amounted to just 5.7% in Ilfov, 5.6% in Giurgiu, 5.1% in Dâmbovița and 3.8% in Călărași. A changed pattern from the point of geographical distribution was gave by arable land, with values reaching 85% in Călărași, 82.8% in Dâmbovița and the lowest percentage was in Bucharest (51.5%). In any case, Bucharest did not yet suffered the total transformation of the urban landscape by building blocks and industrial areas, and sprawl. The forest areas had the highest spread in Ilfov (16.1% of total area), followed by Giurgiu (13.8%) and Dâmbovița (7%). Bucharest city had only 2.8% of total area with forest. Vineyards and orchards once parts of the traditional landscape in this area were already decreased their lots. Largest share or area with vineyards was in Giurgiu (5.5%) and Călărași (2.6%) and lowest level in Bucharest (only 0.3%). Orchards were the most widespread in Bucharest (2.6% of total area), followed by Ilfov (1.8%) and Dâmbovița (1.6%).

Land use map in 2000

Compared with topographical map from 1970s, the CLC map for 2000 at the county level revealed a very changed situation in certain classes of land use (Table 2). At the top is Bucharest case, where urban fabric area has been doubled in nearly 30 years (an increase from 3.6% in 1970 at 64.1% in 2000). A significant increase concerning with urban fabric is taken by Ilfov county which count 10.9% in 2000. In the same time, all counties registered a decreases in the share of arable land, with more drastically decrease in Bucharest City, where the share of such arable land was reduced at 18% and in the Ilfov County where it represent 66.5% of total area (figure 3). Green spaces and recreation site in Bucharest City were almost doubled, from 3.7% on topographical map to 6.4% on the CLC 2000. Vineyards were completely eliminated in Bucharest and almost completely in Dâmbovița. Significant reductions were also in Ilfov (81.49%), Giurgiu (66.29%) and Călărași (65.36%). Orchards are not present in 2000 in Dâmbovița, and almost half level in Călărași (42.57%), Ilfov (44.12%) and Giurgiu (52.38%).

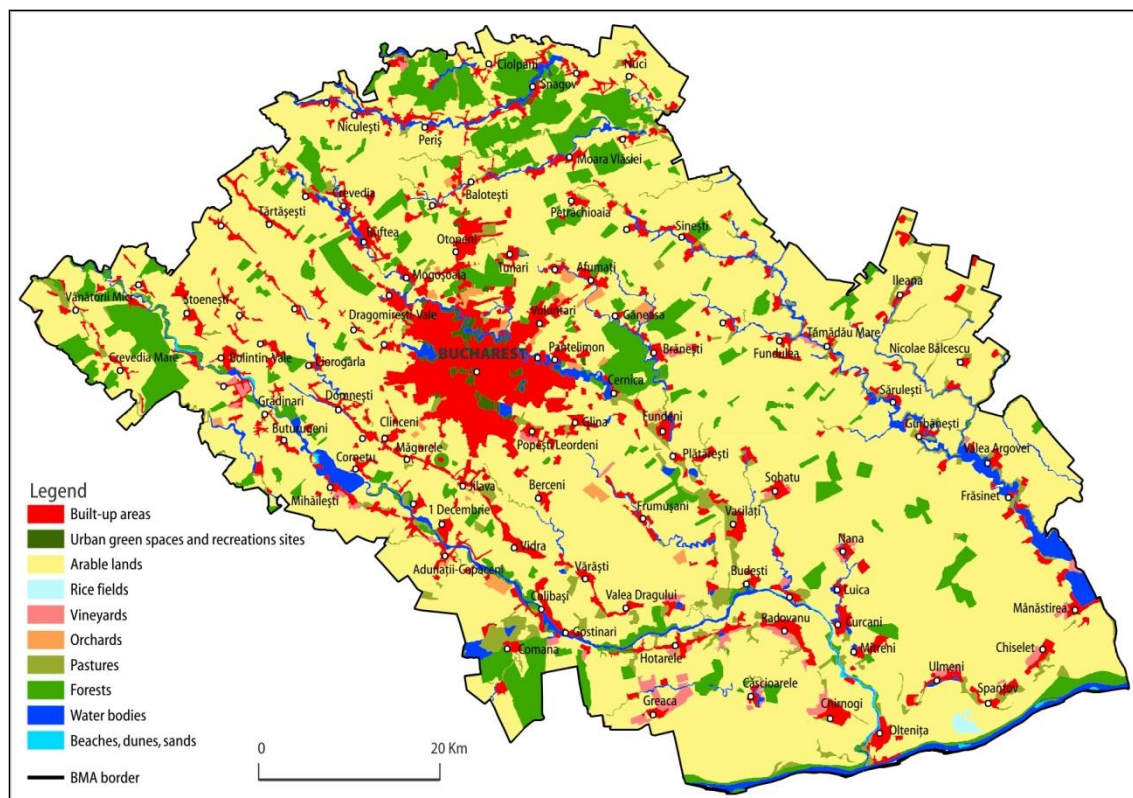


Figure 3. Land use/cover map for 2000

Regarding the others changes occurred in the Bucharest metropolitan area we mention here the increase of forest land in Ilfov, from 5.7% in 1970 to 10.9% in 2000. In Călărași were not registered significant land use changes of the main classes. In Dâmbovița the changes are represented by increase of urban fabric with almost 3% and forestry with 0.6%. In Giurgiu we calculated slight decrease of arable land (1.6%), increase of urban fabric (from 5.6% to 8%), and the effectively reduction of vineyards (from 5.5% to 1.9%).

Determinant of land use / land cover changes

Into the present borders of Bucharest metropolitan area a permanent extended had the arable land, which expanse was obtained by deforestation or reclamation. After digitised of topographical map from 1970 result that the arable land count almost 77% of total metropolitan area, in this sum it is included those of Bucharest City. Only in some parts of metropolitan area the continuity of arable land is interrupted by forestry, especially in the northern area (Snagov, Ciolpani, Moara Vlășiei), in the north-western

area (Crevedia Mare and Vânătorii Mici), south-eastern from Bucharest (Cernica, Găneasa) and in Comana. On the CLC maps from 1990 and 2000 arable land were extended on the 70.5% in 1990 and 71.3% in 2000. Arable land has the largest extension in the south-eastern part of Bucharest metropolitan area, which has the possibility to be developed as and agricultural space.

BMA is situated in a geographic region covered some centuries ago by forestry, known as "codrii Vlășiei". Jordan (1973: 174) analysed the past and present extension of forestry in this area:

"Today forests are the leftovers of Vlășia forestry, incontestable evidences of their presence in the past over the large area. Strong fragmentation and dispersion of forests are determined by human intervention in order to obtain land, actions intensified after 1900."

At the beginning of 20th century the areas occupied by forests were reduced in the Bucharest suburban area. A map from 1921, called *Bucharest City and the surroundings* show us little presence of forests around Bucharest. The forests mapped on the map are

still in present. We mention here forests Buftea, Băneasa, Tunari, Pantelimon, Cernica, Pasărea, Găneasa.

Water bodies of BMA have been transformed by human interventions. Reasons for these actions were to keep away settlement from inundations risks, to build canals for irrigation or for economic use. A series of rivers have water accumulations with huge quantity of water (in Argeş – 52.7 million m³; in Colentina – 46.9 million m³; in Mostiștea – 24.4 million m³; in Dâmbovița – 19.2 million m³) and others are using for fishing (Ioja, 2006: 32).

Vineyards cultivation is an activity with a very long tradition in Bucharest and its metropolitan area. The lands cultivated with vineyard increase in terms of area occupied between 16th and 18th centuries, both in the inner city and at the periphery. Not only in Bucharest were the vine is cultivated only in some private garden or on the blocks walls, but in the all metropolitan area vineyards decreased. Based on digitizing the topographical map from 1970 we calculated an area of 14,181.51 hectares, which represent 2.6% of the total BMA. In 2000 on the CLC, vineyards represent only 4,313.61 hectares, respectively 0.8% of total area.

These figures are not the same with those provided by National Institute of Statistics who gave us data for each municipalities and we calculated that vineyard occupied 8.763 hectares, which means 1.6% of total BMA, respectively 2.16% of agricultural land. Comparative with topographical map for 1970, CLC maps for 2000 illustrate the decline of land cultivated with vine. Here are still remains few patch in the area of Burnazului Plain and in those situated at the eastern of these, on the Danube Valley and Mostiștea Valley. The quality of vineyards is reduced very much, being cultivated only hybrid vineyards, which have an inferior quality. In the future, we expected an reduction almost totally of indigenous vineyards, because EU rules stops the commercialization of vine obtain from this kind of vineyards. Most of them are cultivated in small plots at the village border, alternate with other cultivated vegetables (onion, melon, cucumber and

tomatoes) or in the open field, without technologies specified for vineyards.

Orchards had also a large spread in Bucharest and surroundings. After digitising the topographical map for 1970 we calculated an area with 5,864.4 hectares cultivated with fruit tree, which represent 1.1% of total BMA. After 30 years later, area cultivated with fruit tree decrease at almost half in 2000. Based on CLC 2000 had result an area with 3,028.27 hectares which represent 0.6% of total area. Comparative with the data from National Institute of Statistics, the area calculated for CLC is nearly the same with this from statistics, where count 3,014 hectares, correspondingly 0.56% of total BMA.

Conclusions

The research illustrates that land cover/land use in BMA exhibit significant changes in the last four decades. Land cover displays and increase of area occupied by water bodies, due to the construction of artificial lakes. The strategy on land use demonstrates the preference of landholders for arable land instead of vineyards or orchard. The explanations for the changes on land use are related to the collapse of the former socialist farms and agrarian reforms. After the 90s, the landholders taken their land form the socialist cooperatives but the machineries for a modern agriculture are missing. The first culture affected by this situation are vineyards and fruit tree that needs much money to keep them and to obtain a production efficiently form the economic point of view.

In the area affected by urban sprawl of Bucharest the significant changes is the decrease both of vineyards and orchard and arable land. In this area is extended the land occupied by construction, from residential to industrial or service sector. Few years ago, the agricultural land of this area suffered a strong pressure of urban sprawl, and became the main income source for landowners, especially those from Ilfov County. In that time they preferred do not cultivated their land, waiting to sell it. The economic crisis implies today a decrease of land transactions and some of land will return to agricultural use.

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