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POPULATION DYNAMICS AND LAND COVER CHANGES OF URBAN AREAS

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In order to enable efficient management of spatial development of cities, it is essential to analyse changes in land cover, in the 'consumption' of the land surrounding cities and the attained rationality with respect to the use of already urban land (reflected in the urban population density). This paper provides an overview of the land cover changes in the period between 1990 and 2006, and the potential correlation between the dynamics of the total population change on the one hand, and the land cover change on the other. The initial hypotheses of this paper are: (1) occupation and sealing of productive soil in peri-urban zones is not proportional to the population dynamics of cities and their metropolitan areas; and (2) expansion of soil sealing in peri-urban zones is not significantly affected by the differences with regard to the natural surroundings and historical development of cities, nor by these cities being developed cities or cities in transition, capitalistic or post-socialist cities, etc. These hypotheses are tested and confirmed in the cases of three capital cities in South and Southeast Europe. Regarding the changes in population density, it can be concluded that central/inner-city municipalities became less populated, with sometimes very significant decrease in population density, but without any land cover change, which indicates 'depopulation'. At the same time, outer-city and peripheral municipalities also suffered a decline in population density, while their urban zones extended.

***Key words:** population development and dynamics, land cover change, Belgrade, Rome, Sofia.*

INTRODUCTION

Spatial expansion of European cities has continued at the steady rate in the 21st century, albeit their generally decreasing population growth. In order to enable efficient management of spatial development of cities, it is essential to analyse changes in land cover, in the 'consumption' of the land surrounding cities and the attained rationality with respect to the use of already urban land (reflected in the urban population density). Further steps necessitate examination of the reasons behind these processes, and then controlling and directing urban development by means of applying appropriate policies and instruments of spatial development. This paper is focused on the first part of the problem and provides an overview of the land cover changes in the period between 1990 and 2006, and the potential correlation between the dynamics of the total population change on the one hand, and the land cover change on the other. The initial hypotheses of this paper, based on literature review presented in Chapter 2, are: (1) occupation and sealing of productive soil in peri-urban zones is not proportional to the population dynamics of cities and their metropolitan areas; and (2) expansion of soil sealing in peri-urban zones is not significantly affected by the differences with regard to the natural surroundings and historical development of cities, nor by these cities being developed cities or cities in transition, capitalistic or post-socialist cities, etc. These hypotheses are tested in the cases of three capital cities in South and Southeast Europe.

A brief analysis of land cover change within administrative areas, later performed at the level of administrative units at the local level ('municipalities') of case study cities - Belgrade, Rome and Sofia (Krunić, 2013; Krunić *et al.*, 2014), was conducted using: publicly available dataset from the European Environmental Agency, ESRI ArcGIS Basemaps/ESRI ArcGIS OnLine, official national statistics services and dataset obtained from TURAS project partners (www.turas-cities.org). The following spatial 'datasets' were acquired: soil sealing degree ranging from 0–100% in aggregated spatial resolution (100 x 100m), for the year 2006, urban morphological zones (UMZ data sets for the years of 1990, 2000 and 2006)

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and UMZ changes from 1990–2000 and 2000–2006, Corine Land Cover – CLC raster data sets for the years of 1990, 2000 and 2006, and CLC changes for the period 1990–2000 and 2000–2006 (EEA, 2013).

The following indicators were utilised: absolute (total) population, population size dynamics, population density (measured via the number of inhabitants per unit of artificial land area, that is, 'artificial surface'), structure of land cover by category (by Corine Land Cover – CLC classification), changes within the above land cover categories respectively, and ratio between total and artificial surface of the administrative units.

URBAN DEVELOPMENT OF CASE STUDY CITIES – AN OVERVIEW

The chosen case study cities of Belgrade, Rome and Sofia differ in terms of their geographical position and surroundings, historical development, and particularly in terms of the social and political system they have been intensively developing in since the mid-20th century. However, apart from the observed land cover changes, the common feature of the three cities is the fact they have been developing in the conditions of formally organised legal, spatial and urban planning systems, though with very different experiences regarding the implementation of planned urban development at the local administrative level. This problem was especially noticeable in the analysed period (Maksin-Mićić, Perišić, 2005; Montanari, Staniscia, 2012; RIMED Report 13, 2005). In addition, the three cities have also been researched within the TURAS project (www.turas-cities.org).

The City of Belgrade

Similarly to other post-socialist cities, the process of suburbanization in Belgrade started towards the end of the 1960s, and was intensively underway during the 1970s and 1980s, when the planned construction of new settlements on the outskirts of the inner city, the largest of these being Novi Beograd, was carried out. Almost simultaneously, during the 1970s, the process of deurbanization commenced, with decreasing demographic growth of the city centre and increasing demographic development and illegal/unplanned construction with low density in the peri-urban zone around the whole city (Grčić, 1993; Živanović Miljković, 2008; Spalević, 2010; Petrić, Krunić, 2013). Owing to these two parallel processes, Belgrade did not manage to maintain its compactness – from the year 2000 the dominating process had the characteristics of urban sprawl. Uncontrolled urbanization of Belgrade peri-urban zone is, according to Maksin-Mićić and Perišić (2005), a consequence of so-called 'ostrich attitude' urbanism – reluctance of city authorities and urban planners to solve the housing issues, occurring as a result of intensive population growth, by means of planned building of settlements with state-owned collective housing units, and preparation of planned building of lower-density settlements for the needs of private sector and population. Since 1990, fragmented and incomplete implementation of the housing reform contributed to a sharp drop in legally built residential units, as well as to a serious distortion of the housing market (Vujović, Petrović, 2007; Petrović, 2001). These authors believe that local planning authorities nearly collapsed, which led to a shocking upsurge in illegal construction. The introduction of real estate market, especially in the field of residential construction, marked by extreme economic crisis and high poverty of most inhabitants, had a negative effect on the city development and intensified illegal residential construction (Bojović, Borovnica, 1998; Simeunčević Radilović *et al.*, 2013). In addition, since the end of the 20th century, due to the general trend of moving the production and commercial activities from the city to the periphery, the new poles of development have been formed on the outskirts of the city, as well as in the metropolitan periphery (extremely attractive for agglomeration of business zones near the airport and along highways) (Miletić, 2010). More details about spatial dynamics in the analysed metropolitan area and differences between planned and actual development can be found in the research conducted by Samardžić-Petrović *et al.* (2013).

The City of Rome

The **City of Rome** represents a paradigmatic example of an originally compact city which has gained a more dispersed urban form. During the intensive population growth, there was a rapid expansion of the city around the compact centre during the 1960s and 1970s, but the form of the city remained compact until the early 1980s. In the period of stable population growth and its decline, urban growth was characterized by a rapid sprawl triggered by important socio-economic changes and deconcentration of the compact city, which also caused dramatic land use changes in suburban areas. Driven by massive speculation, the growth of the city was sustained by a strong house-demand from low-income workers only partially satisfied by the local government which strongly encouraged leapfrogging compact settlements developed within authorised local plans. Legal and sometimes spontaneous low-density settlements were also tolerated, creating a complex 'mosaic' landscape (Montanari, Staniscia, 2012). Montanari and Staniscia (2012) observe that the movement of economic activities from cores towards suburbs in metropolitan areas in Rome which took place in the 1991–2001 period was of small scale and scattered, due to feeble job growth and the continuing attractiveness of the city centre for many tertiary sector businesses. Gargiulo Morelli and Salvati (2010) analysed compact vs dispersed urban development on the example of Rome (NUTS 3 prefecture of Rome) in ten-year intervals from 1960–2006. They compared the differential impact of compact urban 'growth' and low-density 'sprawl' on land cover changes (LCCs) and their final effect on changing land cover relationships (LCRs). Conversion to urban land uses was carried out at the urban fringe in the 1960s and 1970s, while expanding progressively far from the city in the 1990s and 2000s. LCCs were found to be relatively different during the 'growth' (1960–1990) and 'sprawl' (1990–2006) phases. Overall, urban areas increased by 0.3% in the 'growth' phase, while only by 0.06% in the 'sprawl' phase. During the 'growth' phase, the land cover classes with the highest probability of being converted to urban uses were arable lands, annual crops, vineyards and pastures. During the 'sprawl' phase, olive grove, orchard and forest surfaces decreased as well, due to the development of low-density built-up areas and infrastructure. That is why Gargiulo Morelli and Salvati (2010) conclude that the victim in this phase might have been the entire 'Agro Romano' rural landscape.

The City of Sofia

A paradigm shift in city-building occurred in the 1960s, when the urban core was encircled by large housing estates. Sofia grew as a unified urban entity with a clear urban edge and managed to remain denser and more compact than other European cities in its surroundings. After the 1990s, changes with regard to urban development emerged (Hirt and Kovachev, 2006). The pattern of spatial development was characterized by growth both outside and inside the city boundaries. Urban sprawl took place in an uncontrolled fashion mainly along the road axes and on the outskirts of the city (RIMED Report 13, 2005). The most notable was the growth of an upscale, low-density, residential suburbia. While the population of metropolitan Sofia declined by 1% from 1991–2001, five districts (Vitosha, Ovca Kupel, Bankya, Pancharevo and Vrabnitsa) experienced growth of population in the peri-urban areas beyond the urban edge established during the socialist period (Hirt and Kovachev, 2006). Slaev (2012) believes that the explanation for this lies in a spectacular boom of the housing

market in the first decade of the new millennium. He points out (Slaev, 2012; 2013) that in the 2000 – 2011 period new housing construction was realized mainly within the compact city, and, to a lesser extent, in peri-urban zones, predominantly in their southwest districts. The quick rise of the post-socialist tertiary sector, growth of small-to-medium local private businesses and, most recently, the emergence of large-scale Western chains occurred across the city and, since the 1990s, shifted from the city centre to peripheral areas. Post-socialist changes, aggressive post-1992 policy of restitution and the subsequent emergence of land as a market commodity substantially reconfigured open spaces in Sofia. Since 1990, Sofia lost 15% of all the public green spaces in the city. In 2003, green spaces were protected by a moratorium on new construction in public parks (Hirt and Kovachev, 2006).

RECENT TRENDS IN POPULATION AND SPATIAL DEVELOPMENT OF CASE STUDY CITIES

The results of the conducted analysis and respective comments about the following demographic and spatial features and processes are given: population dynamics, population density, land cover structures and land cover changes. The analysis covered the period 1990–2006, with respective and necessary estimations according to the statistical data about population, provided by the official national statistical authorities.

Trends in the population development

Population of the **City of Belgrade** increased moderately in the analysed period (Table 1). The most significant rise in population size (measured by 1991–2006 change ratio) was recorded predominantly in peripheral municipalities: Grocka (120.4), Barajevo (120.2), Novi Beograd – central area (118.2), Čukarica (116.5) and Palilula (107.7). Contrary to this demographic trend, a significant decrease ('depopulation') was recorded in three inner-city municipalities (Stari Grad – 78.5, Vračar – 83.1 and Savski Venac – 89.3), as well as in the municipality of Zemun (88.5) and peripheral municipality of Mladenovac (95.5).

Population of the **City of Rome** suffered a mild decline in the observed period. The most significant growth in population size was recorded primarily in some peripheral municipalities: EUR (115.8), Ostia (112.1) and Delle Torri (109.0). The opposite demographic trend, i.e. considerable 'depopulation', was recorded in all inner-city municipalities, especially in San Giovanni (86.1), Prenestino (86.5), Nomentano-San Lorenzo (87.2), Prati (87.8) and Monte Verde (89.2) (Table 2) .

Table 1. City of Belgrade – population development and spatial changes

	Municipality	Population Change Ratio 2006*/1991	1990		2006	
			Population Density (inh/ha)	Artificial/ Total Area Ratio	Population Density* (inh/ha)	Artificial/ Total Area Ratio
1	Zvezdara	102.2	78	0.50	75	0.53
2	Obrenovac	105.5	17	0.10	18	0.09
3	Voždovac	98.4	63	0.17	51	0.20
4	Zemun	88.5	55	0.21	37	0.28
5	Lazarevac	101.6	19	0.08	16	0.10
6	Barajevo	120.2	34	0.03	17	0.07
7	Vračar	83.1	271	1.00	225	1.00
8	Grocka	120.4	20	0.11	23	0.12
9	Mladenovac	95.5	24	0.07	22	0.07
10	Palilula	107.7	58	0.06	43	0.08
11	Čukarica	116.5	35	0.27	45	0.26
12	Novi Beograd	118.2	44	0.15	48	0.16
13	Sopot	101.4	15	0.05	15	0.05
14	Stari Grad	78.5	152	0.85	119	0.84
15	Rakovica	105.6	68	0.45	61	0.53
16	Savski Venac	89.3	33	0.96	29	0.96
	Mean	*103.3*	*62*	*0.32*	*53*	*0.33*

**Estimated population*

Table 2. City of Rome – population development and spatial changes

	Municipality	Population Change Ratio 2006/1991	1990		2006	
			Population Density (inh/ha)	Artificial/ Total Area Ratio	Population Density (inh/ha)	Artificial/ Total Area Ratio
1	Centro Storico	94.1	93	0.98	87	0.98
2	Parioli	93.0	100	0.96	93	0.97
3	Nomentano-San Lorenzo	87.2	105	1.00	91	1.00
4	Monte Sacro	91.6	97	0.23	79	0.26
5	Tiburtina	97.6	82	0.46	70	0.52
6	Prenestino	86.5	230	0.84	218	0.77
7	Centocelle	91.0	113	0.60	92	0.67
8	Delle Torri	109.0	65	0.26	58	0.31
9	San Giovanni	86.1	202	0.90	174	0.90
10	Appio Claudio	97.9	89	0.55	79	0.61
11	Appia Antica	93.2	85	0.36	82	0.35
12	EUR	115.8	36	0.22	39	0.23
13	Ostia	112.1	45	0.27	47	0.29
14		0.0				
15	Arvalia	91.5	456	0.59	475	0.52
16	Monte Verde	89.2	42	0.29	34	0.31
17	Prati	87.8	85	0.76	76	0.74
18	Aurelia	98.7	86	0.24	75	0.27
19	Monte Mario	98.3	97	0.14	90	0.15
20	Cassia Flaminia	101.3	40	0.19	38	0.20

Similarly to the City of Belgrade, a moderate rise in the population of the **City of Sofia** was noted. The population size most significantly rose in some central municipalities (e.g. Poduyane – 143.6), but mostly in southern peripheral municipalities: Ovcha Kupel (137.5), Vitosha (135.7) and Bankya (130.2). As opposed to this trend, some inner-city municipalities (e.g. Sredets – 77.3, Oborishte – 85.4 and Vazrazhdane – 89.2) went through a substantial 'depopulation', as well as north-eastern peripheral municipality of Kremikovtsi (53.6) (Table 3).

Table 3. City of Sofia – population development and spatial changes

	Municipality	Population Change Ratio 2006*/1991	1990		2006	
			Population Density** (inh/ha)	Artificial/ Total Area Ratio	Population Density* (inh/ha)	Artificial/ Total Area Ratio
1	Sredets	53.6	136	1.00	105	1.00
2	Vazrazhdane	77.3	138	1.00	123	1.00
3	Oborishte	85.4	132	1.00	113	1.00
4	Ilinden	89.2	104	1.00	99	1.00
5	Serdika	94.9	33	0.72	35	0.69
6	Poduyane	95.3	53	0.93	78	0.92
7	Slatina	95.8	45	0.91	49	0.92
8	Izgrev	96.9	73	1.00	71	1.00
9	Lozenets	97.2	54	0.77	64	0.83
10	Triaditsa	97.6	80	0.82	76	0.85
11	Krasno selo	98.0	128	1.00	129	1.00
12	Krasna Polyana	98.2	87	0.68	83	0.69
13	Nadezda	98.5	73	0.46	70	0.46
14	Iskar	101.0	46	0.56	44	0.58
15	Mladost	102.4	80	0.75	72	0.81
16	Studentski	110.4	80	0.65	100	0.66
17	Lyulin	114.8	126	0.43	121	0.44
18	Vitosha	119.7	18	0.18	22	0.19
19	Ovcha Kupel	127.6	38	0.24	43	0.29
20	Bankya	127.8	9	0.17	10	0.18
21	Pancharevo	130.2	12	0.05	13	0.05
22	Vrabnitsa	135.7	36	0.25	38	0.28
23	Novi Iskar	137.5	12	0.11	11	0.12
24	Kremikovtsi	143.6	10	0.16	6	0.15
	Mean	*103.5*	*67*	*0.62*	*66*	*0.63*

**Estimated population, ** Data for the year 1992*

Soil sealing and development of the UMZ

According to the provided digital data, the total analysed area[4] of the City of Belgrade covered 3223.2 km^2. Less than 21% of soil, according to the data from 2006, was to some degree sealed by anthropogenic impervious materials. Only about 4.5%, or less than 145 km^2 of the city`s soil was highly sealed. Although the data about the UMZ for Belgrade were not officially provided, they were reconstructed using the same UMZ methodology (ETCTE, 2013). The UMZ of the City of Belgrade was changed and extended by the index of 122.1!

The total analysed area of the City of Rome covered 1285.8 km^2. The data from 2006 reveal that 46% of soil was to a certain extent sealed by anthropogenic impervious materials. More than 230 km^2, i.e. about 18% of the city`s soil, was highly sealed. Overall, the UMZ of the City of Rome extended by the index of 108.1.

The total analysed area surface of the City of Sofia was 1342.7 km^2. Only about 26% of soil, according to the data from 2006, suffered a certain degree of sealing by anthropogenic impervious materials. Additionally, only about 12%, or 161 km^2 of the city`s soil was highly sealed. Overall, the UMZ of the City of Sofia was slightly extended, by the index of 102.7.

Land cover changes

Municipalities with the largest share of artificial surfaces (ratio between the total area of the municipality – TA and total artificial surfaces – AS) in the City of Belgrade in 2006 were inner-city municipalities: Vračar (1.00), Savski Venac (0.96) and Stari Grad (0.84). Contrary to this, artificial surfaces in the peripheral municipalities occupied less than 10% of the total land: Sopot (0.05), Barajevo (0.07), Mladenovac (0.07), Palilula (0.08) and Obrenovac (0.09). During the observed period, land cover of the City of Belgrade slightly changed in favor of artificial surfaces. CLC land cover changed in the general process of transition from 'natural' land cover to artificial surfaces. In total, artificial surfaces covered about 13% more in 2006 than in 1990, at the expense of agricultural areas which decreased by 2%. In terms of the dynamics of land occupancy ('antropogenisation'), considerable changes took place in general, and particularly in the following municipalities: Barajevo (233.3), Zemun (133.3), Palilula (133.3), Lazarevac (125.0), Rakovica (117.8) and Voždovac (117.6). A certain 'deantropogenisation' was detected in the municipality of Obrenovac (90.0) due to the recultivation of the previous ore exploitation areas. (Table 1, Figure 1 and Figure 2)

The data about land cover in 2006 for the **City of Rome** show that the inner-city municipalities of Nomentano-San Lorenzo (1.0), Centro Storico (0.98), Parioli (0.97) and San Giovanni (0.90) had the greatest share of artificial surfaces. In contrast, less than 30% of the total land in peripheral municipalities was occupied by artificial surfaces: Monte Mario (0.15), Cassia Flaminia (0.20), EUR (0.23), Monte Sacro (0.26), Aurelia (0.27) and Ostia (0.29). Land cover of the City of Rome slightly changed in favor of artificial surfaces. In the year of 2006 artificial surfaces covered about 1/3 of the total area. Similarly to Belgrade, CLC land cover changed in the general process of transition from 'natural' land cover to artificial surfaces. In total, artificial surfaces covered about 8% more in 2006 than in 1990, while agricultural areas decreased by more than 4%. In terms of the 'antropogenisation', there were substantial changes in general, but particularly in the following municipalities: Delle Torri (119.2), Tiburtina (113.0), Monte Sacro (113.0), Centocelle (111.7) and Aurelia (112.5). A certain "deantropogenisation" was noticed in the municipalities of Arvalia (88.1) and Prenestino (91.7) (Table 2, Figure 3 and Figure 4).

[4] Differences between the total analyzed area of the cities and areas acquired by rasters can be observed. 'Raster area' is bigger, due to the principle that any part of the pixel covered by vector must be calculated as the whole pixel in the total sum.

Municipalities with the largest share of artificial surfaces in the City of Sofia in 2006 were inner-city municipalities of Poduyane, Slatina, Ilinden, Izgrev, Krasno selo, Oborishte, Sredets and Vazrazhdane, with artificial surfaces coverage up to 92–100%. Contrary to this, artificial surfaces in peripheral municipalities occupied less than 20% of the total land: Pancharevo, Novi Iskar, Kremikovtsi, Bankya and Vitosha. Regarding the land cover of the City of Sofia, there was a minor change in favor of artificial surfaces. Artificial surfaces accounted for only about 1/5 of the total area in 2006. CLC land cover changed in the general process of transition from 'natural' land cover to artificial surfaces. In total, artificial surfaces coverage in 2006 was only about 3% higher than in 1990, at the expense of agricultural areas which, in total, decreased by 2%. With respect to the dynamics of 'antropogenisation', considerable changes occurred in general, but principally in the municipalities of the outer-city and periphery: Ovcha Kupel (120.8), Vrabnitsa (112.0), Novi Iskar (109.1), Mladost (108.0), and Lozenets (107.8). A relatively modest rate of 'deantropogenisation' was noticed in the municipality of Kremikovtsi (93.8) (Table 3, Figure 5 and Figure 6).

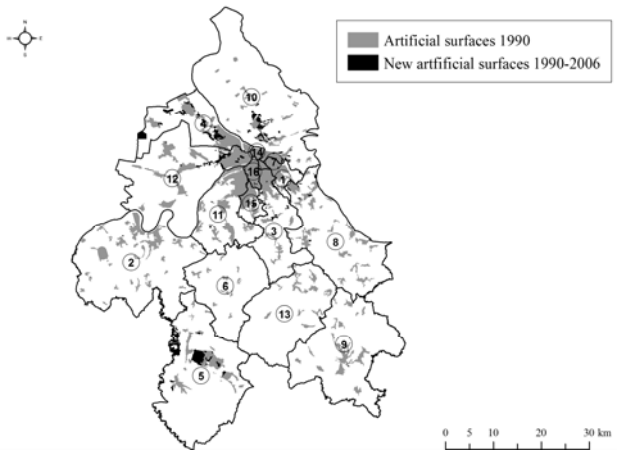

Figure 1. City of Belgrade – Artificial surfaces and land cover change (1990–2006)

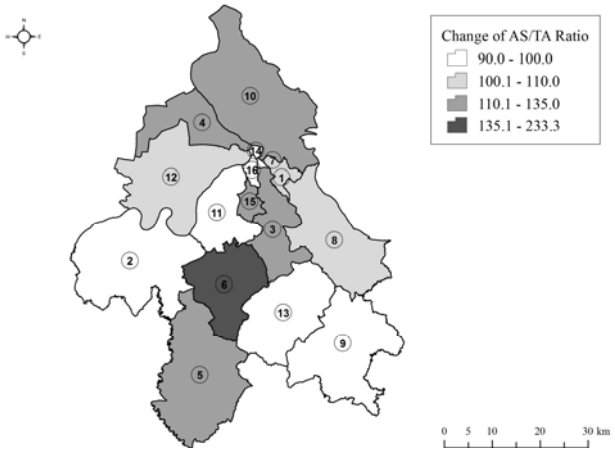

Figure 2. City of Belgrade – AS/TA ratio of administrative units (1990–2006)

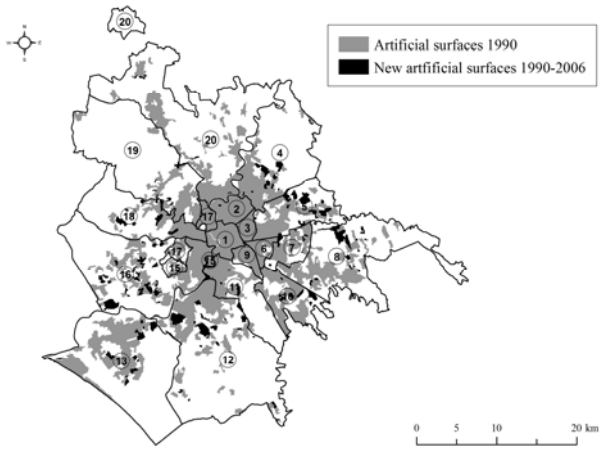

Figure 3. City of Rome – Artificial surfaces and land cover change (1990–2006)

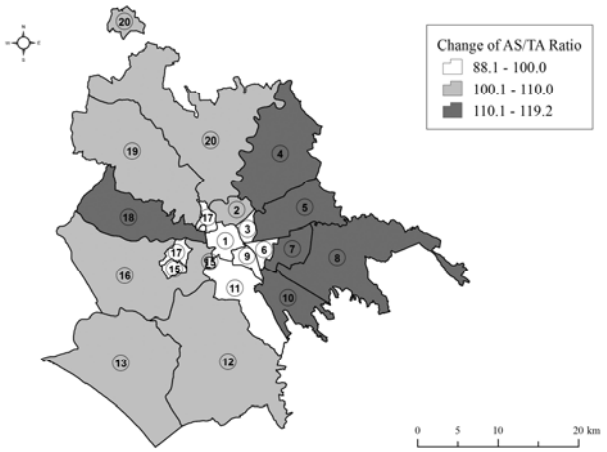

Figure 4. City of Rome – AS/TA ratio of administrative units (1990–2006)

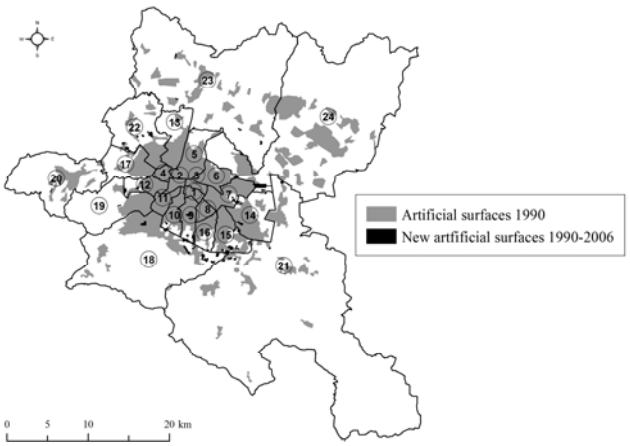

Figure 5. City of Sofia – Artificial surfaces and land cover change (1990–2006)

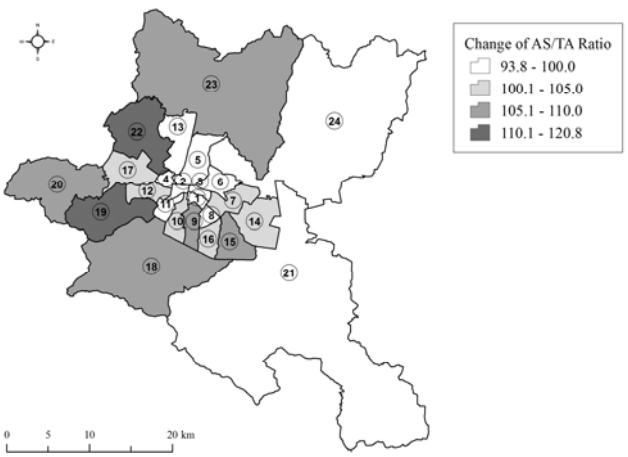

Figure 6. City of Sofia – AS/TA ratio of administrative units (1990–2006)

Population density change

Regarding the population density of the **City of Belgrade** in the year 2006, here measured by ratio between the total population and total artificial surfaces area (inhabitants/ha), the most populated were inner-city municipalities Vračar (225) and Stari Grad (119), whereas the lowest densities were observed in the peripheral, relatively 'rural' municipalities: Sopot (15), Lazarevac (16), Barajevo (17), Obrenovac (18), Mladenovac (22) and Grocka (23). During the observed period and in relation to land cover changes (1990–2006), population density considerably increased in the municipalities of Čukarica (128.6), Grocka (115.0) and Novi Beograd (109.1). Contrary to this, a substantial drop in population density was observed in most municipalities where high 'antropogenisation' was detected: Barajevo (50.0), Zemun (67.3), Palilula (74.1), Voždovac (81.0) and Lazarevac (84.2). It is important to note that population density also decreased in the inner-city municipalities of Stari Grad (78.3) and Vračar (83.0), without land cover change, thus indicating 'depopulation' (Table 1, Figure 7).

The highest population density in the **City of Rome**, in 2006, was registered in the inner-city municipalities of Arvalia (475), Prenestino (218) and San Giovanni (174), while the least populated were peripheral municipalities of Monte Verde (34), Cassia Flaminia (38), EUR (39) and Ostia (47). Related to land cover changes, population density slightly increased in the following municipalities: EUR (108.3), Ostia (104.4) and Arvalia (104.2). On the other hand, most municipalities with high 'antropogenisation' experienced a considerable fall in population density: Tiburtina (85.4), Monte Sacro (81.4), Centocelle (81.4) and Monte Verde (81.0). In addition, population density also decreased in the inner-city municipalities of Centro Storico, Parioli and Nomentano-San Lorenzo, without land cover change, which indicates "depopulation" (Table 2, Figure 8).

The highest density in the **City of Sofia** in 2006 was present in some inner-city and outer-city municipalities (Oborishte - 113, Lyulin - 121, Vazrazhdane - 123 and Krasno selo - 129). Extremely low densities were observed in the peripheral municipalities: Kremikovtsi (6), Bankya (10), Novi Iskar (11) and Pancharevo (13). Consequently, during the observed period and related to land cover changes, the population density noticeably increased in the municipalities of the outer-city and periphery: Poduyane (147.2), Studentski (125.0), Vitosha (122.2), Lozenets (118.5), Ovcha Kupel (113.2) and Bankya (111.1). Quite the opposite trend, i.e. a significant decline in population density, was

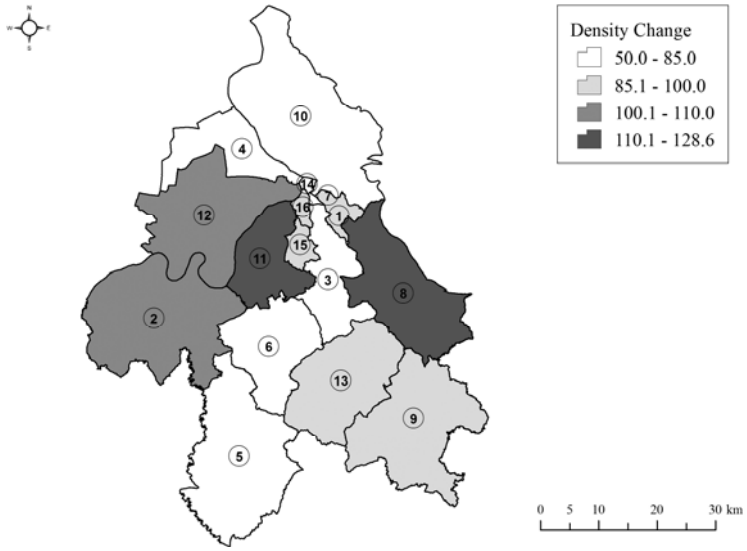

Figure 7. City of Belgrade – Population density changes within administrative units (1990–2006)

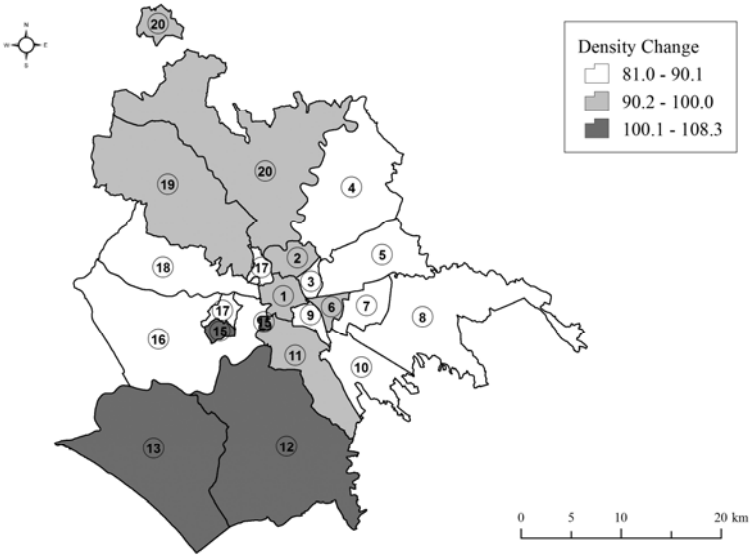

Figure 8. City of Rome – Population density changes within administrative units (1990–2006)

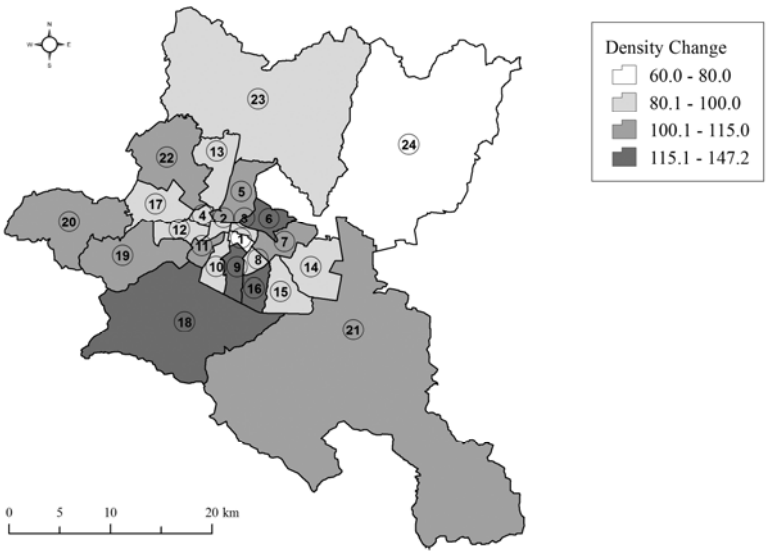

Figure 9. City of Sofia – Population density changes within administrative units (1990–2006)

present in the majority of municipalities, particularly in Kremikovtsi (60.0) and Vazrazhdane (89.1), and also in the inner-city municipalities of Sredets (77.2) and Oborishte (85.6), without land cover change, thus indicating 'depopulation' (Table 3, Figure 9).

BRIEF DISCUSSION – CONCLUDING REMARKS

Relevant references, as presented in *Urban development of case study cities – an overview*, suggest that there exists no clear cause and effect relationship between the expansion of soil sealing in peri-urban zones and differences with regard to the natural surroundings and historical development of cities, nor due to these cities being developed cities or cities in transition, capitalistic or post-socialist cities etc. Nevertheless, it can be concluded that different factors caused similar trends in soil sealing in peri-urban zones in the case study cities.

There are some differences between the respective sizes of the administrative areas of case study cities: the City of Belgrade (3223.2 km^2), the City of Rome (1286.1 km^2) and the City of Sofia (1342.9 km^2). Belgrade has the smallest urban area, or UMZ, in comparison to its administrative area (183.5 km^2, i.e. 5.7%). Likewise, although Sofia has a larger administrative area than Rome, its urban area (259.1 km^2, i.e. 19.3%), or UMZ, is significantly smaller than in the case of Rome (398 km^2, i.e. 31%).

Certain differences are also observable with regard to the population changes. Population of the **City of Belgrade** increased moderately, in total, by the index of 103.3. The most significant increase in population size was recorded predominantly in peripheral municipalities, while a significant decrease was observed in inner-city municipalities. Contrary to Belgrade, population of the **City of Rome** slightly decreased in total, by the index of 96.6. Again, the most significant increase in population size was noted primarily in some peripheral municipalities. In contrast to this demographic trend, all inner-city municipalities suffered a significant 'depopulation'. Population of the **City of Sofia** also increased moderately, in total, by the index of 103.5. The population size most notably rose in some central municipalities, whereas some inner-city municipalities, as well as the north-eastern peripheral municipality, experienced 'depopulation' to a considerable extent.

There were also differences in the dynamics of spatial changes. Namely, while the UMZ of Belgrade extended for about 33 km2, the UMZ of Rome and Sofia extended for about 30 km2 and 7 km2 respectively. It is interesting to note that spatial dynamics of the UMZ or respective artificial surfaces have accelerated after the year 2000 in the cases of all three cities. Development of the UMZ of all three cities was a dynamical process which differed throughout the observed period. There was an obvious correlation between the sealing degree and the intensity of human activity.

Land cover pattern also changed, concurrently with the UMZ development and dynamics. Artificial surfaces development corresponded with the UMZ changes and dynamics. In all three cases, artificial surfaces were mainly developed at the expense of agricultural areas. By using CLC land cover classification it was not possible to track changes inside artificial surfaces, i.e. in the cities' urban tissues.

Occupation and sealing of productive soil in peri-urban zones was not proportional to the population dynamics of the cities. Regarding the changes in population density, it can be concluded that central/inner-city municipalities became less populated, with sometimes very significant decrease in population density, but without any land cover change, which indicates 'depopulation'. At the same time outer-city and peripheral municipalities also suffered a decline in population density, while their urban zones extended (in cases where high 'antropogenisation' was detected).

Further extension of urban zones and "filling" within the existing urban block has been observed since 2006 in all three cities. Detected trends in land cover changes and population dynamics should be taken into account when planning and developing both central and peri-urban city areas. Apart from further research of causalities in land cover changes, successful management of cities necessitates understanding of the citizens' preferences concerning the surroundings they live in (Petrić, 2013) on the one hand, and interests of investors, local authorities and other subjects of overall urban development on the other.

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