ACE 20

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ACE: Architecture, City and Environment = Arquitectura, Ciudad y
Entorno [en línea]. 2012, Año 7, núm. 20 Octubre P. 131-148

ISSN: [1886-4805](https://doi.org/10.18866/1886-4805)

Website access: http://www-cpsv.upc.es/ace/Articles_n20/articles_pdf/ACE_20_SE_23.pdf

UPCommons Access: <http://hdl.handle.net/2099/12644>

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URBAN SPRAWL IN PORTUGAL BASED ON URBAN SYSTEMS SPATIAL BOUNDARIES

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First send: 10-10-2012

Final send: 22-10-2012

Key words: Urban systems, Interaction value, urban sprawl, Portugal.

Abstract

Nowadays, some European countries are facing the most complex process of land-use/land-cover change – the urban sprawl, which in turn has a compound impact on the social and environmental structure of urban areas. This study intends to analyse urban sprawl in mainland Portugal through a comparison of urban land cover changes during the period of 1990-2006, using urban systems as spatial reference units. CORINE Land Cover maps were used to generate time series of urban land cover data. A methodology based on the interaction value was applied to identify the urban systems, using the commuting matrix supplied by the 2001 Census. Urban land cover change analyses, at the urban systems level, allowed for the identification of artificial areas spread patterns. Such spatial information is essential for rethinking new actions that may contribute to more efficient urban planning.

1. Introduction

Reflecting upon urbanization and urban growth leads one to consider that the evolution of any urban area generates changes in its spatial structure particularly in the land-use/land-cover organization. In this process of permanent change some countries are currently facing the phenomenon of urban sprawl. Urban sprawl, common in European cities, is often related to leapfrog discontinuous development, low residential density and dependence on private

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transport (Peiser, 2001; Batty, 2005), promoting social-environment vulnerabilities, chaotic and random land-use patterns, significant unbalances between the city and its surroundings, and imposing a new look on the landscape (EEA, 2006). According to the speed of its development, the urban sprawl still carries a lot of uncertainty regarding its future evolution.

In mainland Portugal, according to a report issued by the European Environmental Agency (2006) urban land cover has experienced a significant change over the last few decades. The report stresses the fact that the Portuguese urban growth trend – particularly residential, services, utilities and commercial areas – was achieved at the expense of agricultural areas and natural grassland. Owing to comparable CORINE Land Cover mapping (CLC), much progress has been made regarding the studies on urban change and urban sprawl analysis based on visual interpretation and remote sensing techniques (for example Freire and Caetano, 2005; EEA, 2006 and Freire *et al.*, 2009). Such spatial databases are essential for rethinking the of new actions that may contribute to more efficient urban planning.

Even though research on urban land-cover changes and urban sprawl may have quite different scopes depending on the scale analysis, this analysis however should be done based on a spatial delimitation of urban occupation. Many studies employ the administrative boundaries -such as municipalities- as their spatial reference unit, analysing and comparing them from different perspectives. Commonly, administrative boundaries at a local level, which are country specific, do not follow the true urban structure that articulates the territory, given the interdependencies that arise from commuting reasons, shopping, errands, and leisure, among others. Such details make the comparison between different urban realities more difficult to perform, particularly when different countries are being considered. In spite of these facts, there is no extensive research on the analysis of urban land-cover changes and urban sprawl using delimitations of urban systems based on more integrated approaches.

In this paper, we apply a methodology based on the interaction value to identify and delimitate the urban structure of mainland Portugal using the commuting matrix supplied by the 2001 Census, in order to analyse and subsequently compare equivalent areas throughout the country. The results show that the methodology of the interaction value, presented in other papers (Roca and Moix, 2005; following Coombes and Openshaw, 1982) using functional criteria, allows for the definition of different levels of territorial organization: local, metropolitan or regional, revealing that interactions produced by daily mobility -mainly required for work-generate functionally autonomous systems, enabling us to identify authentic pieces of urban organization: urban systems⁴. On the other hand, the proposed approach increases the reliability of urban systems delimitation. Therefore, two CLC digital vector maps of the study area were selected for the years 1990 and 2006 and urban land-cover changes were analysed.

⁴ The methodology of the interaction value has been applied in Spain with very satisfactory results (Roca *et al.*, 2009, 2011 and 2012), and has also been tested in several North American metropolises, such as Chicago or Los Angeles, accurately reflecting from their urban to the metropolitan reality (Roca *et al.*, 2011).

2. Study area

According to the Nomenclature of Territorial Units for Statistics (NUTS), the study area, which includes mainland Portugal, is administratively divided into three broad levels: (i) the country corresponds to a NUTS 1 area, which is divided into (ii) seven NUTS 2 regions and (iii) 30 NUTS 3. As has stated “this division of the territory – created at the supranational level for statistical and administrative purposes – runs parallel to the national administrative areas which divide the same spatial surface into 18 districts (*distritos*), 308 municipalities (*concelhos*) and 4,260 local administrations (*freguesias*)” (Rodrigues et al., 2012: 568).

Portuguese municipalities are characterized by their large extension, with 320 km² on average in mainland Portugal as opposed to *freguesias*, which cover only an average of 22 km². Figure 1 shows the local administrative divisions of mainland Portugal, consisting of 278 *concelhos* and 4,050 *freguesias*.

Figure 1. Local administrative divisions

Source: Official administrative map of Portugal (CAOP), 2010.

Figure 2. Locally based workplaces by municipality

Source: By authors from matrix of origin-destination flows.

Table 1 summarizes some mainland districts data, such as total area, local entities that form them and the number of locally based workplaces (WP) from the 2001 Census. We would like to highlight that nearly half of the jobs are located in Lisbon (25.7%) and Porto (19.1%) districts.

Figure 2 shows this higher concentration of jobs around the municipalities of Lisbon and Porto, and highlights the greater weight of coastal municipalities versus inland ones. The study area is one of the fastest developing urban coastal areas in Europe due to urban and population growth and economic activities expansion mainly since independence movements in Portugal's African colonies in 1975 and the country's integration into the European Union in 1986.

Table 1. Main data of the districts of mainland Portugal

District	Area (km ²)	No. of <i>concelhos</i>	No. of <i>freguesias</i>	WP	% WP
01-Aveiro	2,797	19	208	326,692	7.6%
02-Beja	10,257	14	100	58,051	1.4%
03-Braga	2,702	14	515	370,946	8.7%
04-Bragança	6,587	12	299	47,869	1.1%
05-Castelo Branco	6,620	11	160	77,501	1.8%
06-Coimbra	3,969	17	209	176,185	4.1%
07-Évora	7,388	14	91	73,656	1.7%
08-Faro	4,994	16	84	177,167	4.1%
09-Guarda	5,528	14	336	64,151	1.5%
10-Leiria	3,502	16	148	199,995	4.7%
11-Lisboa	2,799	16	226	1,100,999	25.7%
12-Portalegre	6,079	15	86	47,120	1.1%
13-Porto	2,328	18	383	816,364	19.1%
14-Santarém	6,712	21	193	177,499	4.1%
15-Setúbal	5,208	13	82	274,745	6.4%
16-Viana do Castelo	2,215	10	290	88,913	2.1%
17-Vila Real	4,301	14	268	73,916	1.7%
18-Viseu	5,003	24	372	132,326	3.1%
TOTAL	88,990	278	4,050	4,284,095	

Source: By authors from matrix of origin-destination flows.

2. Methodology

2.1 Input data

The purpose of this study is to analyse urban sprawl in mainland Portugal through a comparison of the urban land-cover changes during the period of 1990–2006 using urban systems as spatial reference units. The initial information required us to apply the methodology for urban systems delimitation based on the interaction value of the commuting matrix. In Portugal, the most recent commuting matrix is the 2001 Census⁵. This matrix shows that displacements or mobility flows are seen at two levels: between municipalities, *concelho* of residence and *concelho* of work (Figure 3), and also at a more disaggregated level, from the *freguesia* of residence to *concelho* of work. However, the proposed methodology relies on using the same origin and destination units to calculate the interaction value, because it is a symmetrical value that relates two equal units. Therefore, only the matrix of flows between municipalities -both at origin and destination- is appropriate to delimit the urban structure, although it would be desirable to start from a smaller territorial unit, such as *freguesias*, to actually detect the urban structure beyond municipal administrative boundaries.

Figure 3. Principal displacements between municipalities

Source: By authors from matrix of origin-destination flows.

⁵ Matrix of origin-destination flows made in Portugal for work purposes, modes of transport and average trip length.

For the urban land-cover change and urban sprawl analyses, two CLC digital vector maps -CLC 1990 and CLC 2006- were used. The CLC vector maps have scale of 1:100,000, minimum mapping unit (MMU) of 25 ha and high thematic detail ensured by the nomenclature. It is important to mention that CLC databases contain tree levels of thematic detail, with 44 classes at the most detailed level. The validation procedure carried out for the CLC 1990 and 2006 maps has produced an overall accuracy of 82.84% and 90.2%, respectively, meaning that land-use/land-cover classes are well mapped. See Caetano *et al.* (2009) for more details about the methodology used for the production of the land-use/land-cover maps and their technical specifications.

All spatial information was georeferenced to the ERTS 89 PT-TM06 projection (one of the official projection systems for Portugal defined by the Portuguese Geographic Institute). The integration and spatial analysis of vector data were developed using ArcGIS 10 software (©ESRI, Environmental Systems Research Institute).

2.2 Delimitation of urban systems using the interaction value

The methodology for urban structure delimitation using the interaction value has been thoroughly explained in the literature. In sum, in order to calculate the interaction value (IV) from the matrix of flows between the place of residence and work we have used the following formulation:

$$IV_{ij} = \frac{F_{ij}^2}{REP_i \cdot WP_j} + \frac{F_{ji}^2}{REP_j \cdot WP_i}$$

Where:

i and j are the places of origin and destination, respectively;

F_{ij} and F_{ji} are the existing commuting flows (such as residence-to-work flows);

REP is the resident employed population;

and WP are the locally based workplaces.

Therefore, the value of interaction between i and j is the same as between j and i.

The delimitation of urban systems is conducted in two stages:

1. Generation of the systems from the interaction value: in this first stage all the based entities join up in proto-systems by virtue of their maximum interaction value, so that those proto-systems are closed only in the event that all entities have their maximum interaction value with another entity in the same proto-system and the set is physically contiguous, Proto-systems thus represent the basic pieces into which the territory is structured.

2. Consolidation of proto-systems in urban systems by self-containment and condition of contiguity: proto-systems are consolidated in urban systems in case self-containment (percentage of resident employed population, REP , who works in its own proto-system) equals or exceeds 50%, since it is our understanding that only urban systems that are capable of

retaining at least 50% of their resident employed population can actually be considered a *city*. We believe that this model better represents cities themselves than their administrative boundaries.

Figure 4 shows the urban systems resulting from applying the methodology of the interaction value. The 278 mainland *concelhos* are grouped into 79 consolidated urban systems with a very high rate of self-containment, except for those systems closer to the two major centres of employment: Lisbon and Porto (Figure 5).

Figure 4. Delimited Urban Systems⁶

Source: By authors.

⁶ The name of each urban system derives from the municipality with the highest number of locally-based workplaces.

Figure 5. Level of self-containment of urban systems

Source: By authors.

Figure 6. Employment located in urban systems

Source: By authors.

The dimension of urban systems in terms of workplaces is quite varied. There are two systems with over 500,000 WP and, on the other hand, twelve with less than 10,000 WP; most systems - over 60%- have between 10,000 and 50,000 WP (see Table 2 and Figure 6).

Lisbon and Porto stand out as the main Portuguese urban systems, with over 1,000,000 and 604,240 WP, respectively, both composed of nine municipalities. Between 100,000 and 200,000 WP there are five systems headed by Coimbra, which incorporates the largest number of municipalities, eleven in all, and up to 100,000 WP is Almada, with the third lower rate of self-containment of all delimited systems given proximity of and dependence on Lisbon (only 57%). Table 3 shows the urban systems with more than 50,000 WP.

The methodology based on the interaction value has allowed us to identify the highly asymmetric development of the national urban systems, caused namely by (i) the level of deprivation in terms of the infrastructures needed for urban development (such as roads) especially in inland regions, and (ii) the relationship/interaction between municipalities and the regional economic dynamics, which relies heavily on the spatial location of resources necessary for its development.

Table 2. Distribution of urban systems sorted by WP

Range WP	No. of US	Percentage
<5,000	4	5.1%
5,000-10,000	8	10.1%
10,000-25,000	31	39.2%
25,000-50,000	18	22.8%
50,000-100,000	11	13.9%
100,000-500,000	5	6.3%
>500,000	2	2.5%
Total	79	

Source: By authors.

Table 3. Principal Urban Systems

Urban System	No. of concelhos	REP	WP	Self-containment
LISBOA	9	915,346	1,018,580	96.5%
PORTO	9	591,762	604,240	93.4%
COIMBRA	11	174,102	169,812	90.9%
SANTA MARIA DA FEIRA	5	131,517	132,632	90.3%
VILA NOVA DE FAMALICÃO	3	116,610	118,510	85.3%
GUIMARÃES	3	113,746	113,602	88.9%
ALMADA	3	160,706	107,273	57.2%
BRAGA	3	101,573	99,750	88.0%
LEIRIA	3	91,546	95,621	92.2%
FARO	5	84,833	86,215	95.1%
AVEIRO	5	76,449	80,475	89.7%
SETÚBAL	2	74,610	78,216	80.7%
TORRES VEDRAS	4	78,268	71,446	82.3%
BARCELOS	2	71,968	67,829	84.7%
VILA DO CONDE	2	62,774	58,920	80.8%
SANTARÉM	5	53,308	52,615	86.2%
OVAR	4	56,433	51,552	74.7%
VIANA DO CASTELO	2	52,806	50,873	86.4%

Source: By authors.

2.3 Urban land-cover change analysis and techniques

In order to quantify and examine spatial and temporal change of urban land-cover, CLC maps of the study area were reclassified and aggregated into two broad classes: artificial and non-artificial areas. Furthermore, we have applied a common GIS-based technique, widely used within vector GIS environment. This procedure was carried out by overlaying the reclassified maps to create a spatial-temporal difference map. The result of the overlay easily represents on a single map the urban land-cover change in the Portuguese urban systems in the years 1990 and 2006. In the end, the artificial area percentages and artificial area growth rates of the study area between 1990 and 2006 were computed for each Portuguese urban system.

3. Urban land-cover change and urban sprawl analysis

The derived urban land maps which show the urban land-cover pattern of the study area are shown in Figure 7. The changes in urban land-cover during the study period can be observed in Figure 8. Table 4 shows the artificial area percentages and artificial area growth rates in Portuguese urban systems between 1990 and 2006.

In Figure 8 and for the years under consideration, we can see that urban growth has occurred in almost every urban system. The difference between the more urbanized and concentrated urban growth and the sparse growth of urban land can clearly be seen. In mainland Portugal, the artificial areas have increased by 1,008.72 km² in 16 years, from 1990 to 2006, with an annual growth rate of 2.42%. It is also important to highlight that 58% of this growth has occurred in coastal urban systems⁷. With improvements in terms of urban infrastructures (such as the A24 motorway in northern Portugal and Vasco da Gama Bridge in Lisbon) some of the urban growth is emerging in urban systems near metropolitan areas.

However, the artificial area growth rates increases at different urban systems varied (see Figure 9). Figure 9 and Table 4 show that areas with higher annual growth rates are located in urban systems close to Lisbon and Porto metropolitan areas⁸ (e.g. Paços de Ferreira, Felgueiras, Peso da Régua, Benavente, Montijo and Setúbal, with an annual growth rate of 6.6%, 5.45%, 4.47%, 5.68%, 2.10% and 3.84%, respectively). This means that the urban systems that have gained artificial areas at a greater rate are those that already were the largest Portuguese cities with continuous and compact artificial areas.

The analysis of Figure 8 also reveals higher levels of artificial areas and larger annual growth rates in urban systems located in the Algarve, in the south of Portugal (e.g. Vila Real de Santo António, Portimão, Albufeira and Lagos with an annual growth rate of 5.26%, 3.58%, 3.4% and 3%, respectively). Figure 7 indicates that urbanization in this region is proceeding rapidly, especially along a narrow coastal strip.

⁷ Defined as those urban systems which are located along the coast.

⁸ In spite of this, Celorico de Basto appears as the urban system with the highest annual growth rate in the country (approximately 11%). It seems very unlikely that such a growth rate has actually occurred since this is a rural area in which the urbanization process does not justify such high annual growth rates. This debatable result might have been caused by mapping inconsistencies.

On the other hand, between 1990 and 2006 the inland urban systems have been under slow urban development and have experienced much lower artificial area growth rates (e.g. Moura, Beja, Nisa, Mogadouro and Torre de Moncorvo, with an annual growth rate of 0.59%, 0.77%, 0.83% and 1.22%, respectively).

Figure 7. Extracted artificial areas maps of the study area in (a) 1990 and (b) 2006

Source: Geographical Data Source: CLC, 1990 and 2006.

Figure 8. Urban land-cover changes of the study area between 1990 and 2006

Source: Geographical Data Source: CLC, 1990 and 2006.

Table 4. Artificial area percentages and artificial area growth rates
in Portuguese urban systems between 1990 and 2006

Urban systems	Artificial areas 1990		Artificial areas 2006		Annual growth rate (%) ^a
	km ²	%	km ²	%	
CELORICO DE BASTO	2.26	0.28	12.35	1.52	10.61
PAÇOS DE FERREIRA	11.01	6.59	31.65	18.94	6.60
VILA REAL	12.03	0.82	32.83	2.25	6.27
BENAVENTE	13.57	0.72	33.69	1.79	5.68
FELGUEIRAS	11.25	2.70	26.91	6.45	5.45
VILA REAL DE SANTO ANTONIO	5.44	1.50	12.61	3.48	5.26
CASTELO DE PAIVA	0.76	0.21	1.64	0.46	4.80
GUIMARÃES	28.72	5.92	59.16	12.20	4.52
PESO DA RÉGUA	2.56	0.70	5.24	1.43	4.47
CHAVES	10.30	0.70	19.95	1.36	4.14
SÃO PEDRO DO SUL	7.09	0.87	13.24	1.62	3.90
SETÚBAL	42.10	6.05	77.80	11.19	3.84
VEISEU	26.08	2.06	46.27	3.66	3.58
PORTIMÃO	23.62	3.55	41.86	6.29	3.58
SANTAREM	35.90	1.89	62.09	3.27	3.42
BRAGA	34.30	6.94	59.18	11.98	3.41
ALBUFEIRA	20.75	2.53	35.78	4.36	3.41
TORRES VEDRAS	60.05	6.50	101.87	11.03	3.30
MONÇÃO	25.69	2.71	43.31	4.56	3.26
MANGUALDE	10.05	1.69	16.34	2.74	3.04
LAGOS	18.17	2.54	29.34	4.10	3.00
SERTÁ	7.16	0.34	11.32	0.54	2.86
PORTO	184.43	16.28	286.40	25.28	2.75
MIRANDELA	5.52	0.36	8.56	0.56	2.74
GRANDOLA	12.25	0.53	18.88	0.81	2.70
FARO	49.91	2.69	76.41	4.11	2.66
CALDAS DA RAINHA	20.71	5.21	31.45	7.92	2.61
ARRUDA DOS VINHOS	5.04	3.88	7.62	5.86	2.58
OLIVEIRA DO HOSPITAL	6.08	0.59	9.05	0.88	2.48
ABRANTES	12.81	1.44	19.03	2.14	2.47
AZAMBUJA	12.53	2.98	18.60	4.42	2.47
REGUENGOS DE MONSARAZ	3.49	0.47	5.17	0.70	2.46
VILA NOVA DE FAMALICÃO	53.36	13.01	78.80	19.22	2.44
TRANCOSO	5.70	0.55	8.36	0.80	2.39
LAMEGO	4.28	0.85	6.19	1.22	2.30
AGUEDA	25.67	6.07	37.04	8.77	2.29
VIANA DO CASTELO	36.76	5.75	52.65	8.24	2.25
TORRES NOVAS	24.42	4.55	34.78	6.47	2.21
BARCELOS	31.86	6.72	45.06	9.50	2.17
ARCOS DE VALDEVEZ	4.42	0.70	6.25	0.99	2.16
PORTALEGRE	6.54	0.41	9.19	0.57	2.13
MONTUJO	16.63	3.49	23.26	4.88	2.10
TOMAR	9.70	1.79	13.46	2.49	2.05
ELVAS	7.89	0.90	10.91	1.24	2.02
PONTE DE SOR	4.83	0.43	6.68	0.59	2.02
CASTELO BRANCO	18.88	0.50	25.97	0.69	1.99
BARREIRO	18.80	20.51	25.84	28.19	1.99
BRAGANÇA	10.01	0.33	13.71	0.45	1.96
PORTO DE MÓS	18.45	5.05	25.16	6.89	1.94
LISBOA	295.60	21.29	401.93	28.94	1.92
VILA DO CONDE	24.97	10.81	33.92	14.68	1.92
GUARDA	22.81	0.64	30.96	0.87	1.91
ALMADA	90.60	25.10	122.22	33.87	1.87
SANTA MARIA DA FEIRA	75.07	8.72	101.12	11.75	1.86
MONTE-MOR-O-NOVO	12.28	0.84	16.50	1.13	1.84
CASTRO VERDE	16.39	0.38	21.80	0.50	1.78
ESTREMOZ	21.10	0.92	27.83	1.22	1.73
SÃO JOÃO DA PESQUEIRA	7.00	0.59	9.21	0.77	1.72
COIMBRA	108.59	3.73	141.98	4.87	1.68
ALCOBAÇA	27.13	5.53	35.25	7.19	1.64
TONDELA	12.50	1.70	16.03	2.18	1.55
MAÇÃO	3.90	0.66	4.98	0.84	1.53
LEIRIA	81.61	6.98	103.93	8.89	1.51
FRONTEIRA	2.79	0.46	3.54	0.58	1.49
COVILHÃ	17.75	1.29	22.46	1.63	1.47
AVEIRO	62.35	8.67	77.16	10.74	1.33
SANTIAGO DO CAÇEM	29.02	0.97	35.78	1.20	1.31
SEIA	5.65	0.77	6.92	0.94	1.27
ANSIÃO	5.60	1.19	6.85	1.45	1.25
ANADIA	19.28	5.89	23.53	7.19	1.25
TORRE DE MONCORVO	3.74	0.48	4.54	0.59	1.22
BOMBARRAL	11.24	4.22	13.49	5.07	1.14
POVOA DE Lanhoso	8.76	0.61	10.46	0.73	1.11
EVORA	24.82	0.72	28.87	0.83	0.94
NISA	3.79	0.39	4.38	0.45	0.91
MOGADOURO	5.18	0.42	5.92	0.47	0.83
BEJA	25.20	0.87	28.50	0.99	0.77
OVAR	58.06	16.59	65.26	18.64	0.73
MOURA	10.42	0.47	11.45	0.51	0.59

Notes: ^a The annual growth rate can be found by taking the difference in the natural Logs of the variable at two points in time, divided by the elapsed number of years. Table sorted by annual growth rate (%) in default descending order.

Source: By authors.

Figure 9. **Map of artificial area growth rates between 1990 and 2006**

Source: By authors.

According to the results of the change analysis in mainland Portugal during the period of study, we can characterize urban sprawl as follows:

- The metropolitan areas and the Algarve region have experienced an increase in artificial areas. The sparse artificial areas became dense, spreading away from the urban core. At the urban system-level analysis, we can see this urban sprawl pattern that results from both the metropolitan polarization and the phenomenon of coastal urbanization of the Algarve.
- The larger annual growth rates in artificial areas of the non-coastal urban systems suggest that urban land-cover change is proceeding more rapidly, resulting in a different pattern of artificial areas clusters. This is particularly so in urban systems close to metropolitan areas, such as Peso da Régua, Guimarães, Vila Real, Benavente and Montijo.

- Although some coastal and inland urban systems (e.g. Santiago do Cacém, Ovar, Aveiro, Coimbra, Leiria, Moura, Beja and Mogadouro) presented low artificial area growth rates, the patterns of urban sprawl in these urban systems are quite distinct. On the one hand, the low annual growth rates of Santiago do Cacém, Moura, Beja and Mogadouro reflect: (i) their weak urban dynamics; and (ii) low urban density and discontinuous urban artificial areas. This is mainly due to natural constraints (such as the protected area called Costa Vicentina Natural Park located in Portugal's southwest coast) and the reduced attractiveness of inland urban systems. On the other hand, the coastal urban systems located between Ovar and Alcobaça (central Portugal) present a very scattered human occupation and a detached single-family housing pattern. It seems that this spatial pattern of urban sprawl could be better identified and evaluated at the micro level than at the urban system level and employing a smaller minimum mapping unit.

4. Conclusion

The analysis of urban sprawl in Portugal was based on urban systems spatial boundaries. This analysis has proven to be more adequate than the analysis based on administrative boundaries. We can state that this analysis is more adequate because it allowed us to associate urban sprawl with the influence of the existing urban systems, which are delimited based on the commuting matrix. In fact, the size and rhythm of urban sprawl are determined by both the functional criterion (work place polarization) and spatial interaction.

The spatio-temporal fractal analysis of the metropolitan area of Lisbon carried out by Encarnação et al. (2012) has identified five types of built-up areas: small and isolated built-up patches; dispersed built-up areas; metastatic growth; rapid growth and metastatic consolidation; consolidated compact areas. We believe that these five types can also be found in the metropolitan area of Porto with equivalent fractal dimensions. This means that Portugal has witnessed urban growth and sprawl patterns that are very dependent on the functional dynamics of its metropolitan areas. The same can be said about the coastal area of the Algarve. The remaining territory, structured by a network of medium and small cities, which bear no important structural influence, has observed an accentuated sprawl namely in the coastal area between the metropolitan area of Lisbon and the metropolitan area of Porto. This phenomenon is only seen on a macro scale in the data of the CLC maps for the years 1990 and 2006. Actually, in order to study this phenomenon with greater accuracy we need to use higher-resolution spatial data. In fact, urban sprawl in Portugal between 1990 and 2006, based on the type of dispersed built-up areas, has reached levels that had never been seen before. This is such that the central power, through the Regional Land Use Plans (Planos Regionais de Ordenamento do Território - PROT), has revealed a certain concern which has been translated into measures aimed at controlling urban sprawl.

Acknowledgements

The work described in this paper was substantially supported by the Spanish Ministry of Science and Innovation for the project “Development of a platform for prospective modelling of urbanization processes in coastal areas”, corresponding to the National Plan I+D+I 2010-2012 and by one grant to FARIA de DEUS, R. from Portuguese State Budget through the Fundação para a Ciência e a Tecnologia (Grant No, SFRH/BD/61544/2009).

This paper presents research results of the Strategic Project of e-GEO (PEst-OE/SADG/UI0161/2011) Research Centre for Geography and Regional Planning funded by the Portuguese State Budget through the Fundação para a Ciência e a Tecnologia. We are grateful to the Portuguese National Institute of Statistics for providing the statistic data. We are also grateful for the help and cooperation of Nancy Ruiz.

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