Monitoring planning compliance. Assessment of land use changes in Lezíria do Tejo region, Portugal

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Abstract

Planning enforcement is "probably…the weakest link" in the planning system (Dobry 1975 in Mckay & Ellis, 2005). Detection of breaches of planning control can profit from analysis of aerial photography or aerial imagery (Harris, 2011). Despite its limitations systematic monitoring of land use changes provides an important valuation in planning compliance.

This paper analyses the land use/cover data dynamics in three municipalities of Lezíria do Tejo region (Almeirim, Benavente and Santarém) and aims to support a reflection on the effectiveness of the main development restrictions foreseen in the Portuguese planning system: the National Agricultural Reserve and the National Environmental Reserve. A quantitative analysis of the recently-converted areas will be given, based on the comparison of land-use cartography, COS-1990 and COS-2007.

Official data on unauthorized development (and information on the characteristics and motivation of private actors) is nonexistent. Therefore, the paper provides an important diagnosis and an overall perspective of the built-up increase during two important decades in which the planning system was implemented. Numbers indicate that farmland and environmentally sensitive areas are being reduced, due to land use changes in areas where guidelines and specific rules have been drawn up to guarantee their preservation. These outline the links of compliance and the very rationale of planning law which can aid planners, scholars and administration officers.

1. Introduction

Planning enforcement is "probably…the weakest link" in the planning system (Dobry 1975 in Mckay & Ellis, 2005). The chance of breaches of control being detected is one of the key aspects of effective enforcement (Mckay and Ellis, 2005). Traditional monitoring tasks are based on the labour of enforcement officers 'on the ground', either (1) screening the built environment for detection of unauthorized development, (2) visiting sites to certify compliance with conditions of planning permissions or (3) investigating complaints made by third parties. Such tasks encounter several limitations, one of which relates the legal powers to enter private premises. Evidences of unauthorized development may not be visible from public roads and additional problems arise when entering private property becomes necessary.

Lack of staff and resources is often pointed out as a reason for the absence of active monitoring by public bodies. This is one of the reasons why various municipalities in Portugal (especially small ones) tend to adopt a 'reactionary" enforcement system, in which actions are initiated primarily by reports or complaints made by private citizens (Harris, 2011). Among the three traditional enforcement tasks, screening the built environment for detection of unauthorized development is the one that requires most resources and brings fewer results, as location is uncertain, detections are based on circumstances and offenders usually do not cooperate. Despite its limitations, systematic monitoring of land use changes using Geographic Information System (GIS) to compare land-use imagery offers an important valuation of planning compliance. Although information provided by a "view from above" does not allow

identification of some type of hidden development, it can assist the most difficult of enforcement tasks. The use of such technology does not displace traditional methods but complements "ground" enforcement (Lai, 1998 in Harris, 2011).

Portugal, like other South European countries (where public administration and trust in government are not as high as in northern European countries) has a "tradition" of unauthorized development in privately owned property. On this topic, international literature can be found in Italy (Zoppi, 200; Zanfi, 2013), Greece (Potsiou & Ioannidis, 2006; Potsiou, 2010), and Turkey (Unsal, 2009; Balamir, 2002). Surprisingly, in Portugal, official data on unauthorized development is nonexistent and academic literature is meagre (focusing almost exclusively on illegal settlements in the Lisbon region). Little is known about this phenomenon and even less about the socio-demographic characteristics of those disobeying the law. Individual actions of private actors, either acting intentionally or unaware of regulation, promote deep changes in the territory. Pre-existent urban sprawl, permission to build on agro-forest zones, and exceptions to development restrictions makes it difficult to identify breaches of control to the naked eye. Nevertheless, current leniency of planning and enforcement bodies (both on local and national level) carries shared responsibilities in the malfunction of the planning system. As our research shows, in the previous two decades, extensive development has occurred in rural zones and in areas where guidelines and specific rules have been drawn up to guarantee their preservation. Due to the impact of successive breaches of control, important questions arise for planners and enforcement bodies. What kind of breaches of control are most frequent? What are the characteristics in terms of severity and location? How extensive is noncompliance with development restrictions?

The object of this paper is to estimate location and the extent of built-up areas in National Reserves during the initial period of municipal master plans. Conclusions are supported on quantitative data of transition from agricultural and forest areas to built-up areas in three municipalities of the Lezíria do Tejo territorial sub-unit: Almeirim, Benavente and Santarém. Information was extracted using GIS to compare land-use cartography from the years 1990 and 2007, analyzing national-wide development in restricted areas: National Agricultural Reserve (RAN) and in the National Environmental Reserve (REN).

The paper assesses mostly the responsibilities of planning agencies on plan design, building permits and enforcement (or lack of it). The next section introduces observations on land-use cover-cartography in Portugal, and explores definitions necessary in understanding results, e.g. of development in built-up areas. In section 3, we explain the methodology regarding selection of case-studies, technical specifications to obtain quantitative data, limitations and expected results. Section 4 introduces the main features of the Portuguese planning system, starting with brief notes on administrative organization, characteristics of municipal master plans, development requiring a permit, and diagnosis of unauthorized development. Section 5 presents data on case-study municipalities and results of comparative land-use cartography, which show the incidence of built-up areas according to National Reserves zoning.

2. Monitoring planning compliance

2.1 The use of land use/cover cartography for plan monitoring

Extensive photographic survey requires appropriate data, technology and expert staff, which may be an impediment for wide implementation. At a local level, none of the municipalities in Lezíria do Tejo uses COS or even aerial photography to monitor breaches of control. Reasons are probably related to aerial imagery cost (still high and beyond small municipalities' budgets), lack of geographic information system staff, and enforcement leniency.

Systematic monitoring through aerial imagery can probably be found in more developed countries. However, in Portugal there is little tradition in using aerial imagery to monitor planning compliance. The sole (and probably isolated) example we encountered was a project undertaken by the Geographic

Portuguese Institute (today Territory General Direction), that created an interactive information system directed "to support the planning and management of the coast, allowing a global vision and locally supported by geographic information, which promotes integration of bodies and users, and promotes continuous updating of knowledge on coastal dynamics" (CCDR-LVT, 2014, pp. 120). This project, initially called "Support system to restore compliance" (Sistema de Apoio à Reposição da Legalidade) had its name changed in 2012 for a designation with less enforcement tone: "Support system of administration of coastal resources" (Sistema de Administração do Recurso Litoral). One of the initial aims of this project was to report on the methodology used to identify alleged breaches of control in coastal areas, by the analysis of aerial imagery and master plans zoning Barbeiro (2011). Despite several cases identified, no direct consequences were published. However, information may have been used by government bodies to support the future demolition of noncompliant development in the coast, announced on the media (see section 4.4.).

Cartography analysis for land-use changes monitoring is used today more intensively in academic environments. As such, the methodology and results presented in this paper is an outcome from a combination of different academic researches.

2.2 Definitions

"Unauthorized development" definition is diverse, and international readers should be aware that planning control may be different in different countries. We have adopted the expression "unauthorized development" (not "illegal development") as it is more commonly used in planning enforcement literature in Europe (Mackay and Ellis, 2005) and America (Burby *et al*. 1998). The term "illegal" may also be found in planning texts, but usually referring to "illegal settlements", which are either named "squatter settlements" (when built with no landowner permission on private or public land) or "semi-unauthorized settlements" (when they had their origin in the division of agricultural/non-urban plots). We also make a distinction between "noncompliant" and "unauthorized" development to differentiate situations that fail to meet planning compliance (and therefore cannot be legalized through retrospective applications) from general breaches of control, undertaken without a permit or not in accordance with a building permit (that may or may not be legalized in the future).

As for development, the British planning system operates on the basis of a definition of development that includes series of activities, including "building, engineering, mining and other operations, as well as material changes of use" (Harris, 2011). Similarly, Hong Kong Planning Department (2015) interprets development as "carrying out building, engineering, mining or other operations in, on, over or under land, or making a material change in the use of land or buildings". The Portuguese Building Control Law[1] defines the corresponding "operação urbanistica" as a "material urbanization, building, use of buildings or land, as long as, in the latter case, not exclusively for agricultural, livestock farming, forestry, mining or public water supply purposes". Additionally, "building", it is regarded as "the activity or the result of the construction, reconstruction, extension, alteration or maintenance of a building for human use as well as any other construction that incorporates ground on a continuing character".

In Britain certain activities that can be excluded from building control are hard to define, such as the one captured in the illustrative phrase of "use incidental to the enjoyment of a dwelling house" (Harris, 2011). In the same way, in Portugal the expression "construction that incorporate ground on a continuing character" feeds debate on how long and which characteristics are acceptable for a construction to be considered of "no continuing character". The discussion reveals the complexity of day-to-day planning enforcement.

"Built-up areas" considered in our research is less extensive than "development" definition. Buildings use changes, increase of height or floors to existing buildings, under land development and isolated

[1] Decree-Law no. 555/99 OJ (PT) December 16 [legal framework for urban development and construction works] with amendments.

detached buildings were not monitored in the GIS comparison of land-use cartography. With a minimal cartographic unit of 1 hectare, "built-up areas" should be regarded as "large areas of buildings, pavements and any other construction works that cause a visible transformation of the soil (i.e. highways and railway infrastructures)".

3. Methodology

3.1 Selection of the case-study municipalities

Selection of the case-study municipalities was based on several factors, such as: geographic association, master plans date, incidence of development restrictions and availability of information. Almeirim, Benavente and Santarém are municipalities connected by the Tagus River and belong to one of the most productive agricultural administrative sub-territorial units in Portugal, Lezíria do Tejo. Away from the coast, in the third ring of the Lisbon metropolitan area, municipalities comprise a large area of rural land, scattered with small-to-medium urban areas. Agriculture is strongly connected to the large floodable areas in the Tagus Valley, and urban areas development is influenced by the main transportation connections to Lisbon.

Due to its agricultural potential and environmental sensitivity, this sub-territorial unit is largely covered by the main Portuguese planning development restrictions: the National Environmental Reserve and the National Agricultural Reserve. As such, it provides an interesting field of observation on location of land-use changes.

The Municipal Master Plans of the case-study municipalities came in force either in 1993 (Almeirim) or 1995 (Benavente and Santarém), which provides that results are close in the matter of years of implementation. In these three municipalities, master plan information is already incorporated in Geographic Information Systems, and was made available by the administrative body of the Inter-municipal Community of Lezíria do Tejo with the academic projects AGRIMET-MOD (PTDC/ATP-EUR/4910/2012) and DAUME (ANR-10-STRA-0007) in view.

3.2 Land-use database specifications

We use the official Portuguese maps of land use/cover for 1990 and 2007 (called COS1990 and COS2007) at the scale of 1:25,000 and with a minimal cartographic unit of 1 hectare. No official COS is available between these dates, but the time-frame suits the purpose of this research as it allows an assessment of the land situation in 1990 (before any Municipal Master Plan was approved) and later, 12/14 years after its implementation.

The maps were produced by the Territory General Direction based on orthophotomaps with four spectral bands (blue, green red and near red). These datasets were photo-interpreted with an average interpretative accuracy of 95%. The Land-Use Cover was divided in hierarchical levels, from level one containing five primary types (artificial areas; agricultural areas and agroforestry; forests and natural and semi-natural areas; wetland; waterbodies) to level five containing up to 190 classes. For the purpose of this study we use level one, extracting three major Land-Use Cover classes: artificial, agricultural and forest and semi-natural areas. The master plan zoning was produced at the same spatial scale of the Land-Use Cover maps, e.g. 1:25,000, thus allowing overlay and comparative analysis.

RAN and REN zoning works as independent "layers", from soil classification zoning and from each other. This means National Reserves zoning overlap soil classes and also overlaps each other. Other "public utility restrictions" were not considered in the analysis because they have local specifications and we were looking for a transversal methodology that could be duplicated in other municipalities. So that results are clear, we defined the total area in the RAN, the total area in REN, and the overlap quantity (that should be deducted for assessment of area exclusively in either RAN or REN).

3.3 Methodology limitations and expected results

Land-use cartography has limitations that should be considered in monitoring and planning enforcement. On the one hand it depends on the correct interpretation of the images and/or reliability of automatic remote detection methods. On the other, one cannot assume directly that these are breaches of planning control, because plan implementation and restrictions have a time gap (previous-to-plan approved development may take a few years to show on aerial imagery) and, also, planning restrictions have exemptions and thus may not be an impediment for specific land use changes.

In this research, both these considerations are relevant. Time gap effect exists because between the first land-use database (1990) and Municipal Master Plans approval (1993 and 1995), increase of built-up area has certainly occurred. Second, as explained in the next section, RAN and REN regulation law allows certain type of land use changes, under specific conditions. So, land use changes identified in RAN and REN areas should be considered as alleged illegalities (that merit further analysis on more detailed aerial imagery and on the "ground") but are not necessarily unauthorized. Furthermore, the research does not make a distinction between private development and public construction (i.e. roads, railways and other public amenities). Closer analysis shows that the number concerning public roads is not very relevant, except in the case of Benavente municipality, where a highway was constructed during the time-frame of this research.

Nevertheless, the paper provides an important diagnosis and an overall perspective on the location of the built-up increase during two important decades, in which the planning system was implemented in the case-study municipalities (as in the rest of Portugal). Results allow a quantitative analysis that can support an assessment of the efficiency of the main development restrictions in Portugal. Numbers reflect the extensive increase of built-up areas between 1990 and 2007, in urban but also in rural and development-restricted areas, evidencing the decline of environmental, agriculture and forest uses. Besides providing support for the conclusions of this research, this data outlines the links of compliance and the very rationale of planning law which can aid planners, scholars and administration officers.

4. Overview of the Portuguese planning system

4.1 Administrative organization

The 1976 Portuguese Constitution establishes a three-tier structure of sub-national government: regional, municipal and civil parishes. Each of the 308 municipalities is responsible for plan design, planning control, enforcement and post-enforcement administrative legal tasks. Certain government bodies also have enforcement powers, i.e. in coastal areas, national parks and heritage sites. There are no regionally elected administrations on the mainland, although regional planning governmental structures do exist. Regional Coordination and Development Commissions (CCDR) are composed of regional representatives of the Central Administration, and overall revision of zone changes in master plans are subject to theirs opinions. Geographically, they correspond to the five EU's nomenclature of territorial units.

4.2 Characteristics of municipal master plans

Municipal master plans cover the entire municipal area and were enacted all over the country, mostly in the decade of the 1990's. They carry legal-regulatory powers - this means building permits must accord with these planning instruments and authorities are usually obliged to issue the permit if the plans allow. Permits may be issued directly from them as lower-level detailed plans are not mandatory, neither frequent. Accordingly to Campos (2007), during the previous decade there was an annual rate of 7 Urbanization Plans, and 24 Detail Plans in 224 municipalities.
"Soil classification" zoning provides general rules for building permits, such as indexes and height limits. Setbacks and other specific location determinations are not common. Small settlements may have only a couple of soil classifications; medium cities, several classes and sub-classes. Zoning may relate to roads and other geographic boundaries (not always clear) but are detached from plot configuration.

As such, a small plot may be covered with two or three different classes and building rights may be ambiguous.

Municipal master plans also integrate several "public utility restrictions", related, for example, to water resources, heritage conservation, infrastructures protection (i.e. roads and railways), preservation of forest, environmentally sensitive and agricultural land. These last two matters correspond to the legal figure of National Environmental Reserve (REN) and National Agriculture Reserve (RAN), being the two most extensive public utility restrictions in Portugal, and covering major areas of its land. Environmentally sensitive areas are always covered by REN and may have a double "protection", which means additional restrictions, i.e. in those integrated in *Rede Natura*, Natural Parks and the Coastal Zone. Public utility restriction oblige owners or municipalities to request an external opinion on permit applications. Despite a general interdiction on development for National Reserves, exceptions are defined in specific laws[2] and certain land-use changes can be allowed under a positive external opinion of the corresponding administrative body[3]. Greenhouses, warehouses, infrastructures tourism facilities (under specific conditions) and "projects of national interest" are examples. In general, conditions for positive external opinion for land-use changes in RAN tend to be "softer" that in REN. In rural areas with no public utility restriction, building permits depend exclusively on compliance with master plans and municipality powers.

Case-study municipalities had their municipal master plan approved either in 1993 or 1995, and have made several amendments (five in Almeirim, seven in Benavente and 13 in Santarém) but no overall revision. Initially, in agricultural or agro-forest classes (corresponding to rural areas) construction of new buildings, including dwellings, was allowed with a minimum plot-size of 3.000m2 or 5.000m2. After 2010, the situation changed. To prevent further urban sprawl, the Regional Plan for the West and Tejo Valley Region "forced" municipalities to increase the minimum plot-size to 40.000m2 for new dwellings. However, the previous minimum plot size still stands for other uses, such as tourism, warehouses, farming and industry facilities.

Despite a 10-year updating requirement, more than 2/3 of Portuguese municipal master plans have not yet accomplished their overall revision (Campos, 2011). Many of the 1990's master plans and reserves zoning in force today seem "out of place" when compared to aerial imagery.

4.3 Building control and exemptions

Building control was initiated in Lisbon and Porto in 1864[4], and was unevenly implemented in the rest of the country between 1951 and the 1970's[5]. Since then building and occupancy permits are required for every use. Currently, the Legal Framework for Urban Development and Construction Works[6] defines which development requires permission. After 1999 (when it was first enacted) several of its 13 amendments introduced, changes the scope of development control. The most relevant was the 2007 one[7], which introduced a building-certificate procedure to simplify and accelerate the building permit procedure and amplified construction works exemptions from building control (for details on building procedures see Pedro *et al*., 2009). Today, permanent structures of less than 10m2, greenhouses up to 20m2, changes inside existing buildings (unless it affects structure), exterior paving inside a plot, fences up to 1,80m away from public roads and other simple construction works, do not require a permit or certificate. On the other hand, changes to a roof, painting a façade on a heritage site and other use-

[2] Exceptions for development in National Agriculture Reserve are established in Ordinance no. 162/2011 OJ (PT) April 18 and for National Environmental Reserve in Ordinance no. 419/2012 OJ (PT) December 20.
[3] Regional Body of Agricultural Reserve for RAN and Regional Coordination and Development Commissions for REN.
[4] Royal Decree OJ (PT) December 31.
[5] Decree-Law no. 38382 OJ (PT) August 7, 1951 made building permits mandatory for the main urban areas and later each municipal council decided building control commencement outside the main urban areas.
[6] Decree-Law no. 555/99 OJ (PT) December 16 with amendments.
[7] Decree-Law no. 555/99 OJ (PT) December 16 amended by Law no. 60/2007, OJ (PT) September 4.

changes, do require permission. Any construction work (even a major one) undertaken by public bodies is also exempt from building permits.

All these forms of development must comply with existing plans and restrictions, regardless of the need to obtain a building permit. This means that even the above mentioned greenhouses, fences or small structures, when located in national reserves, still require positive external opinion of the corresponding administration body.

4.4 Diagnosis of unauthorized development

As mentioned before, official data on unauthorized development is nonexistent. Nonetheless, some sense of the scale can be provided by literature and other items from the authors' research. Among all forms of different unauthorized development, semi-unauthorized settlements in the Lisbon metropolitan area have had the most interest from scholars. During the 1960s and 70s – the years of quick urban expansion – illegal settlements (both squatter and semi-unauthorized) appeared on the fringes of a few Portuguese cities. The appearance of semi-unauthorized settlements was most rampant in the Lisbon area, where farmland was subdivided into small plots and sold thorough the dubious systems of "avos" and jointly-owned property (Cardoso, 1983; Rolo, 2006). Although this phenomenon has ceased and special laws[8] were enacted to deal with the complex urban situation, authorities are still challenged with how to deal with extensive unauthorized development in the past. However, in most municipalities across the country, as in our case-study municipalities, these kind of settlements are not common.

Squatter settlements on public land are also rare in Portugal but, besides Lisbon, they also exist in the Lezíria do Tejo sub-region. In the 1950's, a few settlements appeared in Tejo river margins/banks, where Avieiros (fishermen) started building their wooden stilted houses on public and floodable land (Gaspar and Palla, 2009). Some of these have become permanent houses, and grown into small villages, such as Caneiras in Santarém, Palhota in Cartaxo and Escaroupim in Salvaterra de Magos. Due to their small size and lack of any administrative solutions, they remain disregarded by local and national authorities.

Building and land-use changes on privately-owned property are the most frequent pattern of unauthorized development in the majority of Portuguese municipalities, as it occurs in our case-studies. However, very little has been written about. Around the city of Porto and the center of the country, "property was already quite divided (rural plots with smaller areas) and therefore subdivision of plots was not as significant [as in Lisbon], existing mainly detached unauthorized buildings on plots already registered properly" (Matos, 1990: 195). Back in 1986, the article on the Municipality of Évora (1986), presented in the "New Conference on Illegal Settlements", revealed that in the historic center of Évora and the rest of the municipality, 32% of the total development had no permit. Regarding new buildings it would correspond to 23%, and additions and other changes to existing buildings more than 50%.

From the beginning of the 1990s the literature on unauthorized development is even scarcer. Nonetheless, some numbers of non-compliant development can be found on the media. In 2005, the Institute for the Conservation of Nature reported 3241, unauthorized buildings in protected areas (Diário de Notícias, 23/02/2005). One year later, the Director of the North Coast Natural Park announced the demolition of more than 200 noncompliant buildings in the town of Apulia, in Esposende municipality, "including 97 storage rooms, 78 houses, (56 of which were second residence) and seven commercial buildings, including restaurants" (Diário de Notícias, 22/06/2006). Recently, in 2014, the "Government promises to demolish 835 unauthorized buildings on the coast this year" (Público e Lusa, 12/03/2014). Despite non-compliance with planning standards, many of these buildings were erected in the 1970-1990's and are "old problems" of enforcement.

Today, while cases where entire new buildings are raised without a permit are not frequent, smaller infringements are common, in the form of construction not in full accordance with a building permit,

[8] Decree law no. 804/76 OJ (PT) November 6 and later, Law no. 91/95, OJ (PT) September 2 with the amendments introduced by the Law no. 10/2008, OJ (PT) February 20.

unauthorized additions to existing buildings, or unauthorized conversion of an otherwise legal building. An insight of the use of noncompliant development can be provided by partial results of an (unpublished) survey of one of the authors, on the attributes of noncompliant buildings for which a retrospective application has been submitted (and denied) by Santarém municipality. According to the survey undertaken in 2013, 89 retrospective applications were denied by the Santarém land management department between 1995 and 2012. Since an application may be for more than one construction (i.e. house, swimming pool or warehouse), they regard 122 construction activities. The survey reveals that single houses' building activities were the most frequent, corresponding to 68% of the total number (84 cases). Of this, the construction of entire houses in vacant plots show the lowest number (16 houses) and house extensions and "outbuildings" (i.e. sheds, barns, or garages) were more frequent (respectively 30 and 38). Fences - most of them related to housing - are also common and represent 12% of the total activity (15 cases). Industry, warehouses and commerce were not as frequent: each show results of between 6 and 7 cases. Rare are noncompliant development activity such as quarries' support facilities, swimming pools and farm buildings (1 to 2 cases). The absence of noncompliant multi-family dwellings should be noticed. This survey provides an example of developments activity in a "sample" Portuguese municipality that encompasses both urban and large rural areas.

5. Case-study municipalities

5.1 Socio-economic and geographic characteristics

Image 1 – Leziría do Tejo location and administrative organization
Source : Abrantes, P., from CAOP, 2010

Almeirim, Benavente and Santarém are municipalities in the third ring of "Greater Lisbon" and belong to the same sub-territorial unit entitled Lezíria do Tejo (Figure 1). It extends over 4,275 km², comprises 11 municipalities and about 250,000 inhabitants. Santarém is the main city, where 25% of the Lezíria do Tejo population is concentrated (as well as commerce, services and public amenities). It plays a major role in the organisation of the territory, together with the municipalities of Almeirim (23,403 inhabitants) and Cartaxo (24,574 inhabitants). Benavente (29,388 inhabitants) is part of another urban axis, together with Salvaterra de Magos (22,053 inhabitants) and Coruche (19,931 inhabitants), which, due to expansion of highways, are now integrated in the logistical and business structure of Lisbon.

Table 1. Data on population in 1991 and 2007 in Almeirim, Benavente and Santarém.

Municipality	Surface (km^2)	Population 1991	Population 2007	Population increase
Almeirim	222	21 505	22 998	1493
Benavente	521	18 871	27 376	8505
Santarém	557	62 980	63 023	43
Total	1300	103356	113397	10041

Source: Nacional Statistic Institute

The axis Santarém-Rio Maior is an important link to the West coast. Extensive commuting dynamics with Lisbon metropolitan areas is indicative of current urban development (Sá Marques and Alves, 2010). According to the Census data regarding daily trips, in 1991, five to 15% of students / work force of the municipalities of Cartaxo, Salvaterra de Magos and Benavente, commuted to Lisbon. In 2001, Santarém and Almeirim joined the preceding municipalities. They all recorded daily commuting of about 15 to 25% (Abrantes, 2013). According to Portuguese Census the region gained 25,000 new residents between 1960 and 2011, and from 1991 to 2001 the region recorded a population growth of 14,500 people. Population dynamic is reflected in an increasing soil sealing.

Among case-studies, Benavente and Santarém municipalities have approximately the same area (521 and 557Km2[9]), and Almeirim about half that (222km). Table 1 shows population variation for the years for which statistics are available, and closer to the land-use cartography dates used in our comparison: 1991 and 2007. Santarém remains the municipality with more people (more than 62 000 inhabitants) but Almeirim and Benavente changed positions: in 1991 population was higher in Almeirim and lower in Benavente (21,505 and 18,871 inhabitants), but in 2007 it was the other way around (22,998 and 27,376). Population increase was more significant in Benavente (8505 inhabitants), low in Almeirim (1493 inhabitants) and minimal in Santarém (only 43 inhabitants).

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5.2 Municipal Master Plan data

Municipalities land size is 221km2 in Almeirim and about the double in Benavente and Santarém (521 and 556 km2). Concerning soil classification in municipal master plan, each of all three municipalities have about the same proportion of rural zones (87-89%) and non-rural zones (11-13%). However urban

[9] Municipality surface in 2007, previously to administration limit changes in 2013.

and developable zones are distributed differently: Santarém has a large urban zone (9%) but the lowest developable zone (2%) and Benavente the opposite, with 5% of urban zone and 7% of developable zone. Almeirim has the same approximated proportion of urban and developable zones (7 and 6%). This difference reveals differences in plan design and, as a consequence, in strategies of land management.

Table 2. Data on Municipal Master Plan of Almeirim, Benavente and Santarém.

Municipality	Almeirim		Benavente		Santarém	
Year of Master Plan	1993		1995		1995	
	Area (Km^2)		Area (Km^2)		Area (Km^2)	
Master Plan Zonning						
Soil Classification						
Urban zones	16,12	7%	28,41	5%	48,46	9%
Developable zones	13,62	6%	36,68	7%	9,74	2%
Agricultural or agro-forest zones	191,93	87%	456,10	88%	498,64	89%
National Reserves						
Areas in the RAN	105,26	48%	138,09	27%	150,96	27%
Areas in the REN	112,04	51%	315,17	61%	208,56	38%
(Areas in the RAN + REN)	95,85	43%	132,01	25%	88,89	16%
Areas with no RAN or REN	100,21	45%	199,94	38%	286,21	51%
Total area with National Reserves	121,45	55%	321,25	62%	270,63	49%
Total area outside National Reserves	100,21	45%	199.94	38%	286.21	51%
Total municipality surface	221,66		521,19		556,84	

Source: Project AGRIMET and CIMLT, 2014

National Reserves cover a large portion of total municipalities land, ranging from 49% in Santarém to 62% in Benavente. Analysing each national reserve total: area in the RAN is higher in Almeirim (47%) and lower in Benavente and Santarém (26% and 27%); and as for area in the REN, restrictions are more stringent in Benavente (60%), Almeirim (51%) than in Santarém (37%). Note that numbers concerning to RAN and REN should not be added, because there is land covered by both national reserves. Overlap of RAN and REN occurs 43% of the total land in Almeirim, 25% in Benavente and 16% in Santarém.

The high incidence of REN in Benavente is explained due to the existence of large protected area of Tajo Estuary, which is additionally protected by NATURA 2000 network. In the Northwest of Santarém municipality there is also a large area of REN interconnected to the Natural Park of Serras de Aires e Candeeiros.

5.3 Results of comparative land-use cartography (1990-2007)

Our research findings (Table 3) demonstrate the impact of forest and agriculture transformation, into built-areas in development-restricted areas such as the National Agriculture Reserve (RAN) and National Environmental Reserve (REN). From the total of transitional land-use changes between 1990 and 2007, a large percentage (43%) of Almeirim's built-up areas occurred on land covered by National Reserves. The ratio is lower in Santarém (33%) and in Benavente (27%), however, corresponding to much more built-up land: 5,57km2 and 5,10km2 respectively. These sound "big numbers", even taking into account the time-gap between 1990 and master plans' dates, legal exceptions and highway construction. It should be noticed that in Almeirim and Benavente, numbers in National Reserves are higher than agricultural or agro-forest areas not classified by RAN, where development was allowed with a (rather small) minimum plot-size.

Our survey also demonstrates that built-up areas affect REN more than they do RAN, which is also unanticipated, as positive external opinion on development is more difficult to obtain in REN than in RAN. In Almeirim the difference between the two reserves is not significant (1%), probably because of a larger overlap of both national reserves. Results are more revealing in Benavente and Santarém:

differences between 1990 and 2007 show that the large majority of built-up areas in reserves occurred in REN (25 and 24%) and just a small percentage in RAN (4% and 12%).

Table 3. Built-up areas by National Reserves zoning in Almeirim, Benavente and Santarém

Municipality	Almeirim Area (Km^2)		Benavente Area (Km^2)		Santarém Area (Km^2)	
Built-up areas transitions (COS 2007 - COS 1990)						
Forest + agriculture areas > Built-up areas in agricultural or agro-forest areas not classified as RAN	0,19	5%	3,71	19%	6,48	38%
Forest + agriculture area > Built-up areas in RAN	1,59	40%	0,83	4%	2,03	12%
Forest + agriculture areas > Built-up areas in REN	1,64	41%	4,84	25%	4,18	24%
Forest + agriculture areas > Built-up areas in RAN+REN	1,51	38%	0,57	3%	0,63	4%
Total Forest + agriculture areas > Built-up areas in National Reserves	1,71	43%	5,10	27%	5,57	33%
Total Forest + agricultural areas > Built-up areas	4,01		19,19		17,09	

Source: Own elaboration based on project AGRIMET and CIMLT data

These results show that development restrictions in master plans may have either encountered too many breaches of control or exceptions in granting building permits, and that the current planning system may not be effective in the protection of environmental and agricultural land.

6. Conclusions

In this research we aim to provide an overall perspective of land-use changes and efficiency of master plans restrictions, based on the comparison of land-use cartography in three Portuguese municipalities: Almeirim, Benavente and Santarém. The adopted methodology may become an important tool to complement traditional enforcement methods for detection of breaches of control, to be used by Portuguese municipalities.

Research demonstrated a high incidence of built-up areas on National Agriculture Reserve (RAN) and National Environmental Reserve (REN). Numbers may disquiet planners, as development seem to have occurred "out of place" – built-up areas in National Reserves corresponds to 27 to 43% of total agricultural and forest land transformed into built-up areas. Between 1990 and 2007 in two of the case-studies, more built-up areas occurred in Natural Reserves than in agro-forest areas with no RAN (where development was allowed with a minimum plot-size). Despite development restrictions, a total of 12,38km2 was transformed into built-area in the three case-study municipalities. Analysis of data also revealed that built-up areas tend to occur more often in REN than in RAN, which is contradictory to the degree of restrictions. Population dynamics in these three municipalities had positive (but moderated) growth which does not justify the high numbers for built-up area increase. Farmland and environmentally sensitive areas are being reduced, due to land use changes in areas where guidelines and specific rules have been drawn up to guarantee their preservation. These results meet the criticism of Pardal (2006:27) of this "sectorial" vision of the planning system. "The body of laws on spatial planning which prevailed the previous four decades fostered easy business in the real estate sector, increased clandestine, rewarded development and construction of poor quality (…)".

Much research on unauthorized development in Portugal has yet to be done. Future research using GIS can provide more detailed information on new built-up areas (according to master plan classes) and types/uses of development (using other hierarchical levels of Land-Use Cover cartography). Methodology can also be sharpened to identify solely unauthorized development in private plots and hence become a more precise tool in the detection of breaches of control.

7. References

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