THE INFLUENCE OF PDM IN THE TRANSFORMATION OF LISBON METROPOLITAN AREA'S PERI-URBAN SPACE

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1. Introduction

- **Context**

The urban sprawl has been accentuating itself over the past decades, motivated by profound economic and cultural changes within the populations, voluminous public investments in infrastructures and private investments in enterprises that seek better accessibility and larger sites. This phenomenon has been particularly intense in AML – Lisbon Metropolitan Area.

The legal framework of instruments of territorial management[1] accounts to the municipal master plans the definition of models for the spatial structure of their territory, summarizing both development strategies and land-use planning. Thus, the focus of solving the urban sprawl is addressed to municipal master plans (PDM), which play a paramount role as a tool in land managements (PDM).

Planning is inseparable from assessment; indeed the latter presents itself in three fashions: *ex ante*, *in continuum* and *ex post*, all having in common a reliance on performance indicators which construction requires the collection, production, update, flow and sharing of information.

The performance indicators for the assessment and monitoring of municipal land plans (PMOT) submitted to the reports on the status of the land (REOT) should follow the guidelines of the National Indicators and Data Base Planning and Urban Development, in course of preparation.

The 2nd report of the drafting system, points out the construction on rural land as a critical factor whose scope extends to the "(…) identification of the volume of building permits in rural land and, within it, in areas known to possess any building, (…)" (DGOTDU, 2011, p. 18). Yet in discussion, are the indicators and their critical aspects.

In addition to these indicators that describe the performance of execution from the PMOT, a new indicator was developed through out this paper, describing the permissiveness of the existing regulations, with the potential to be applied in determining the causes of possible faulty implementations.

The construction of the permissiveness indicator aims to estimate the influence of PDM in the dynamics of peri-urban areas of AML, which is an important component for the assessment of the implementation of these plans.

[1] Established by Decree-Law No. 380/99 de 22th de September

2. Land dynamics in the peri-urban areas of AML

The Regional Land Plan for the Metropolitan Lisbon Area – PROTAML – was approved with a view to respond to both the guidelines of the Law of Planning Policy and Urbanism – LBOT – and the instruments of sectorial policies, through a set of guidelines regarding the revision of the land-use policies of the municipalities covered.

The plane stablishes a land model based on the identification of its major systems, networks and joints at a sub-regional level, in order to define a framework to be followed by the PMOT of the municipalities involved. The scope of this procedure is to propose a metropolitan board of environmental enhancement and protection structures composed of corridors and ecological links that overall promote the containment of the urban sprawl.

For the purpose of this paper, the strategic orientation aimed at the containment of the urban sprawl and the consolidation of multipolar structures targeting the reduction of the manifestations of suburbanization in rural areas paramount.

– Recent alterations to the rural sites

The most notorious transformation that has taken place in rural sites of AML is the suburbanization, whose definition is yet subject to further studies.

Peri-urbanization been studied in Bretain and France 1940's. There is no consolidated definition for this term, even though one should understand it as a set of phenomena that occur during the transformation from rural to suburban land. Therefore, it's important to conceptuallly clarify the peri-urban areas:

> Peri-urban areas are sites in a situation of transition from strictly rural to urban sites. The peri-urban areas grant, generally, an urban-rural join outreach, and can eventually become totally urban. People represent an essential component of the peri-urban areas, as they are in a process of progressive urbanization.

(CEMAT, 2007, p. 2)

Another type of transformation that can arise in association with suburbanization is the fragmentation of urban spaces. This phenomenon occurs in two directions: aimed to the inner city with the abandonement of neighborhoods that give rise to degraded areas; and aimed to the outside, according to theme parks.

> The creation of theme parks in cities has a correlation with tha apperance of office parks and shopping centers at the intersection of metropolitan highways, the new residential and leisure areas, whether across the rivers or in the outskirts of urban sites, are new forms of mismatching and segregated urbanism.

(Gaspar, 1995, p. 171)

– Impacts of the transformations

The process of suburbanization has manifested itself spontaneously, disjointed and contrary to the State's role in planning the use and occupation of the land: "(…) the city grew roughly based nunicipal

(…)" (Sá Marques, 2004, p.157).

Sá Marques (2004), also raises environmental issues arising from urban sprawl , that affect the quality of life of the population: the time and resouces spent on commuting and its negative impacts on public health and personal relationships; and the reduction of social interaction caused by the greater physical distance.

As far as problems of infrastructures of urban sprawled areas observed in the country are concerned, Domingues (1999, p. 52) states that "(…) it is also true that creating infrastructures in whole urban areas is impossible, especially in terms of sanitation, thus making environmental disruptions become evident. (…)".

3. Policies of construction in rural sites

It is under a perspective of preservation of the rural landscape that all the regulations from the legal framework consisting of a PDM are analysed, regarding their potential to promote or inhibit the forces of peri-urbanization in rural sites. The assessment was done in two fashions, in conformity with the context:

1) Descriptive, justifying judgements;

2) Qualifying, reducing symbols to value judgements:

▲ – Influences positively the preservation of the rural landscape.

□ - Omission without practical consequences for the issue concerned.

◆ - Brings about interpretation doubts that may lead to contradictory results.

■ - Omission that endangers the protection of the rural environment.

▼ - Influences negatively the preservation of the rural landscape.

The key issues raised by such provisions depending on the topics covered are:

i. Classification of the soils.

ii. Existence of infrastructures in the public space.

iii. Building regulation and road classification.

iv. Constraints to the eligibility to the right to build.

v. Technical building constraints.

The building regulations were examined to identify the relevant criteria and the manner in which the aggregation should be made in order to make them comparable. The resulting data was then compiled in an analytical framework.

• Construction of the permissiveness indicator

This step began with the selection of relevant criteria to the decision. The ones selected were only those that present in most of the regulations and that reveal differences in the levels of potential building public space, minimum area of buildable parcels, proof of fulfillment of social and economic constraints and buildable parameters.

For the criteria “infrastructures” and “proof” a family of indirect descriptors was defined (Table 1):

▲- Considers the norm suitable to the preservation of the features and identity of the rural landscape.

□ - The regulations are lacking, though the omission is innocuous.

◆ - Can prove appropriate or inappropriate depending on punctual circumstances.

■ - Reveals a relevant omission: the lack of regulations leads to a situation of vulnerability.

▼- It’s considered inadequate to preserve the potential or effective rural space.

SCALES		
ORDINAL		CARDINAL
DESCRIPTION	SYMBOL	
Adequate disposition	▲	0,00
Irrelevant omission	□	0,25
Ambivalent disposition	◆	0,50
Relevant omission	■	0,75
Inadequate disposition	▼	1,00

Table 1 – Value scale for the criteria "infrastructures" and "certification"

For the criterion “minimum area of building parcel” a set of quantitative descriptors was defined, based on the minimum areas of the parcels required in each PDM for the purpose of edification, for each functional category of buildings (Table 2).

MUNICIPALITIES	ACTIONS	DESCRIPTORS
Barreiro, Cascais, Loures, Mafra, Moita, Odivelas, Palmela, Seixal, Sesimbra, Sintra, V. F. Xira	Ap = ∞ ha	Ap = ∞ ha
Alcochete	Ap ≥ 10,00 ha	10 ha ≤ Ap < ∞ ha
V. F. Xira	Ap ≥ 5,00 ha	5,0 ha ≤ Ap < 10 ha
Loures, Montijo, Odivelas	Ap ≥ 4,00 ha	4,0 ha ≤ Ap < 5,0 ha
Alcochete	Ap ≥ 3,00 ha	3,0 ha ≤ Ap < 4,0 ha
Mafra, Montijo, Sintra	Ap ≥ 2,00 ha	2,0 ha ≤ Ap < 3,0 ha
Alcochete, Almada, Barreiro, Cascais, Loures, Mafra, Moita, Montijo, Odivelas, Palmela, Seixal, Sesimbra, Setúbal, Sintra, V. F. Xira	Ap ≥ 1,00 ha	1,0 ha ≤ Ap < 2,0 ha
Alcochete, Almada, Cascais, Loures, Mafra, Odivelas, Oeiras, Palmela, Sesimbra, Sintra	Ap ≥ 0,50 ha	0,5 ha ≤ Ap < 1,0 ha
Mafra	Ap ≥ 0,25 ha	0,2 ha ≤ Ap < 0,5 ha
Barreiro, Cascais, Sintra, V. F. Xira	Ap ≥ 0,20 ha	
Montijo	Ap ≥ 0,10 ha	0,1 ha ≤ Ap < 0,2 ha
Almada, Barreiro, Loures, Mafra, Moita, Montijo, Odivelas, Palmela, Seixal, Sesimbra, Setúbal, Sintra, V.F. Xira	Ap > 0 ha	0 ha < Ap < 0,1 ha

Table 2 - Descriptors of the criterion “minimum area of building parcel”

MUNICIPALITIES	ACTIONS	DESCRIPTORS
Alcochete, Barreiro, Cascais, Loures, Mafra, Moita, Montijo, Odivelas, Oeiras, Palmela, Sesimbra, Setúbal, Sintra, V.F. Xira	At = ∞ ha ²	At > 150 m²
Setúbal	At ≤ 2400 m²	
Alcochete	At ≤ 1500 m²	
Alcochete	At ≤ 900 m²	
Moita, Montijo, Palmela, Sintra	At ≤ 500 m²	
Moita, Palmela	At ≤ 400 m²	
Almada, Barreiro, Loures, Odivelas	At ≤ 350 m²	
Alcochete, Mafra, Montijo, Palmela, Seixal, Sesimbra	At ≤ 300 m²	
Loures, Odivelas, Seixal	At ≤ 250 m²	
Loures, Moita, Odivelas	At ≤ 200 m²	
Moita, Montijo, Sesimbra	At ≤ 150 m²	0 m² < At ≤ 150 m²
Loures, Odivelas	At ≤ 100 m²	
Barreiro, Cascais, Loures, Mafra, Moita, Odivelas, Palmela, Sintra, V.F. Xira	At = 0 m²	At = 0 m²

Table 3 - Descriptors of the criteria "buildable parameters"

For the criterion “buildable parameters” (Table 3) regulations set maximum absolute values, construction indexes[2] or a combination of both. Its value is known only in cases where the maximum construction area allowance was fixed, without any link to the area of the parcel.

- **Functions of local values**

The operationalization of a criterion requires the creation of a cardinal scale of local preference, whose values associated with each descriptor of the ordinal scale are determined by the chosen model. The latter is based on the attractiveness of each descriptor, in the decision maker’s perspective.

The direct rating method was used to set the values for each level of impact of ordinal scales.

For the criteria “infrastructures” and “certification” cardinal scales were set identical (Table 1).

For the criterion “minimum area”, whose descriptors are shown in (Table 2), a cardinal scale of specific ratios was created (Table 4).

Finally, in the range of assessment criteria descriptors, there is the “buildable parameters” (Table 5). One can observe that the differences in

SCALES	
ORDINAL	CARDINAL
Ap = ∞ ha	0,0
10 ha ≤ Ap < ∞ ha	0,1
5,0 ha ≤ Ap < 10 ha	0,2
4,0 ha ≤ Ap < 5,0 ha	0,3
3,0 ha ≤ Ap < 4,0 ha	0,4
2,0 ha ≤ Ap < 3,0 ha	0,5
1,0 ha ≤ Ap < 2,0 ha	0,6
0,5 ha ≤ Ap < 1,0 ha	0,7
0,2 ha ≤ Ap < 0,5 ha	0,8
0,1 ha ≤ Ap < 0,2 ha	0,9
0 ha < Ap < 0,1 ha	1,0

Table 4 – Value scale of the criterion “minimum area of building parcel”

[2] Referenced to areas of the parcels.

attractiveness between the prohibition to build and build up to 150 m^2 and between this value and an unlimited value are not identical; this reflects the susceptibility of absolute limits exceeding 150 m^2 and highlights the completeness of this criterion when the descriptor is *At = 0 m^2*.

SCALES	
ORDINAL	CARDINAL
At > 150 m²	0,00
0 m² < At ≤ 150 m²	0,75
At = 0 m²	1,00

Table 5 – Value scale of the criterion "building parameters"

• Assessment of the alternatives

In order to prossecute with the construction of the indicators of regulatory building permissiveness, it was necessary to scale the assessment process as follows:

– Intracriteria weighted aggregation

The existence of different constraints for functional typologies determined that the marks awarded according to each criterion to the regulatory building framework of each subspace needed to be weighted. This weighting was based on its quantitative representation.

The λ coefficients (Table 6) represent the share of each function in the total built units. Once applied to the marks awarded for each criterion its function in each subspace, they resulted in the assessment framework of the subcategories of spaces.

WEIGHTINGS	
FUNCTION	λ
Habitation	0,73
Exploration	0,16
Various	0,11

Table 6 – Distribution functions of the total units built

• Global assessment

In the weighting made for the inter-criteria assessment, the replacement rates were obtained through the swing weights method, applied to the scores given by the decision maker (Table 7), thus setting a decision in *strictu sensu*.

SELECTION CRITERION	PUNCTUATION				REPLACEMENT RATES
	1st	2nd	3rd	4th	
Minimum area of parcel	100				0,65
Existence of infrastructures	30	100			0,20
Proof of fulfillment	15	50	100		0,10
Building parameters	7,5	25	50	100	0,05
Reference (*benchmark*)	0	0	0	0	0,00
TOTAL	152,5				1,00

Table 7 – Rates of replacement inter-criteria (swing weights method)

• Discussion of the results

After a first trial, it was found that five municipatity some indicators had very low values, even though they comprised only 20% (Cascais), 25% (Loures, Sesimbra and Vila Franca de Xira) and 33%

(Odivelas) of the municipality's totals. All the remainder indicators of the five municipalities stood within the interval [0,54 , 0,94] in line with the majority of there maining eleven municipalities presented.

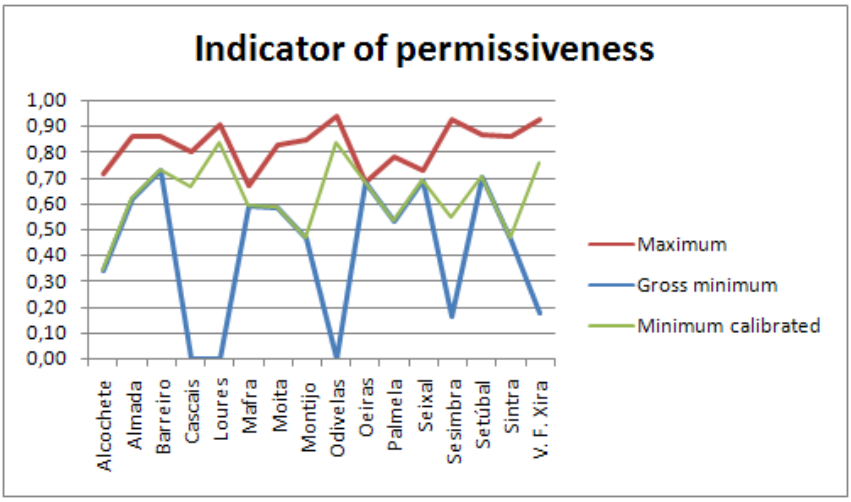

Figure 1 – Calibration of the indicators of permissiveness of the PDM.

These considerations made an interesting issue emerge – that of carrying out a comparison with the segregation of representative cases. The risks of the experiment were minimal and acceptable since the removal of the samples that are beyond the default behavior itroduces a lower disturbance to the reliability of the model than its maintenance entails (Figure 1).

- **Classification of the PDM**

The comparability between the municipalities has been reinforced with the use of the maximum and the calibrated minimum indicators. However, the sorting in order of increasing permissiveness requires the determination of a reference average value for each municipality.

An interesting information extracted from this ordination is the positioning of the municipalities that were located in selected samples: Palmela, Montijo and Mafra ranked among the least permissive (Table 8).

MUNICIPALITY	INDICATOR	ORDER
Odivelas	0,90	1st
Loures	0,87	2nd
V. Franca de Xira	0,83	3rd
Moita	0,82	4th
Barreiro	0,78	5th
Sesimbra	0,78	6th
Setúbal	0,76	7th
Almada	0,74	8th
Cascais	0,71	9th
Seixal	0,71	10th
Sintra	0,68	11th
Palmela	0,68	12th
Oeiras	0,68	13th
Montijo	0,68	14th
Mafra	0,64	15th
Alcochete	0,47	16th

Table 8 - Ordination of the municipalities

4. Analysis of samples

- **Selection of land samples**

To survey the current situation, the material that served as a basis for the analysis consisted on the satellite photographs of the

year 2005, avaiable on *Google Earth*.

However, it was necessary to randomly select representative samples to be used with the sampling CECAC – Executive Committeeon Climate Change grid, composed of 2km x 2km square (Figure 2).

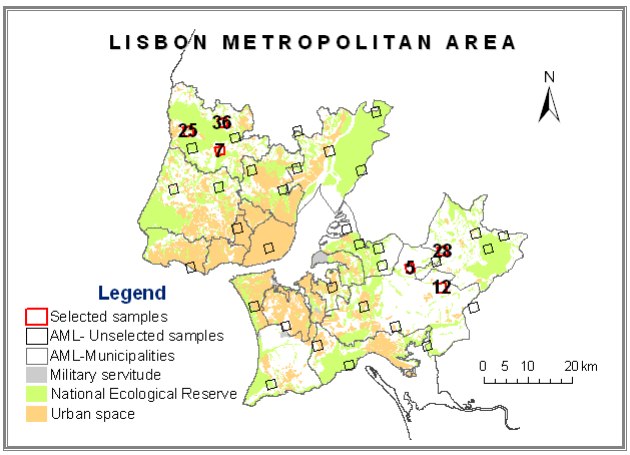

Figure 2 – Samples of the territory for analysis

There is, however, to make an observation: the examination of orthophotomaps 1995 demonstrates that, in general, municipalities have extended city limits in the PDM typically rural areas, in some cases without any buildings that date. As this work is concerned not formally urban spaces, such territories are not included in the analysis.

Thus, the procedure was generalized, which resulted in few remaining viable samples. Interestingly, the selection included three samples taken north of the Tagus (No. 7, 25 and 36 in Mafra) and many other south (No.5, 12 and 28 in Palmela / Montijo). Also interesting are their locations in relation to the capital: the two groups are quite distant from Lisbon and follow a NW-SE diagonal.

This peculiarity is clearly understood when identifying an "urban triangle" (Figure 3) within the AML, with vértices in Vila Franca de Xira, Cascais and Setúbal: by subtracting this triangle, the remaining areas of AML are located northwest and southeast, having the Setúbal peninsula to the southwest, where the only available sample of the grid had to be discarted because it coincides with the National Ecological Reserve and the Natural Park of Arrábida (Figure 2).

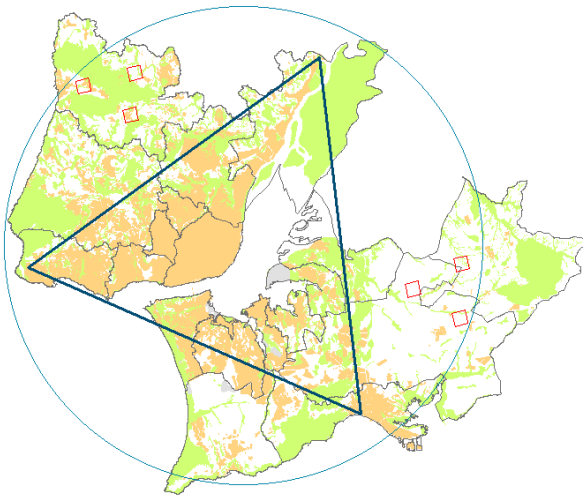

Figure 3 - "Urban triangle" from AML

Another peculiarity is the difference between the two groups in terms of terrain, more rugged in the north, the average size of farms, most in the south and accessibility to Lisbon, best in the north. The sample area south of the Tagus lacked good connections to the capital, which came to change with the construction of the Vasco da Gama Bridge, realized after the entry into force of the majority of PDM

Therefore not surprising that the area north of AML was most urbanized in 1995 and that, conse-

quently, the samples north of the Tagus match residual spaces between urban and REN and therefore subject to greater speculation (Figure 4).

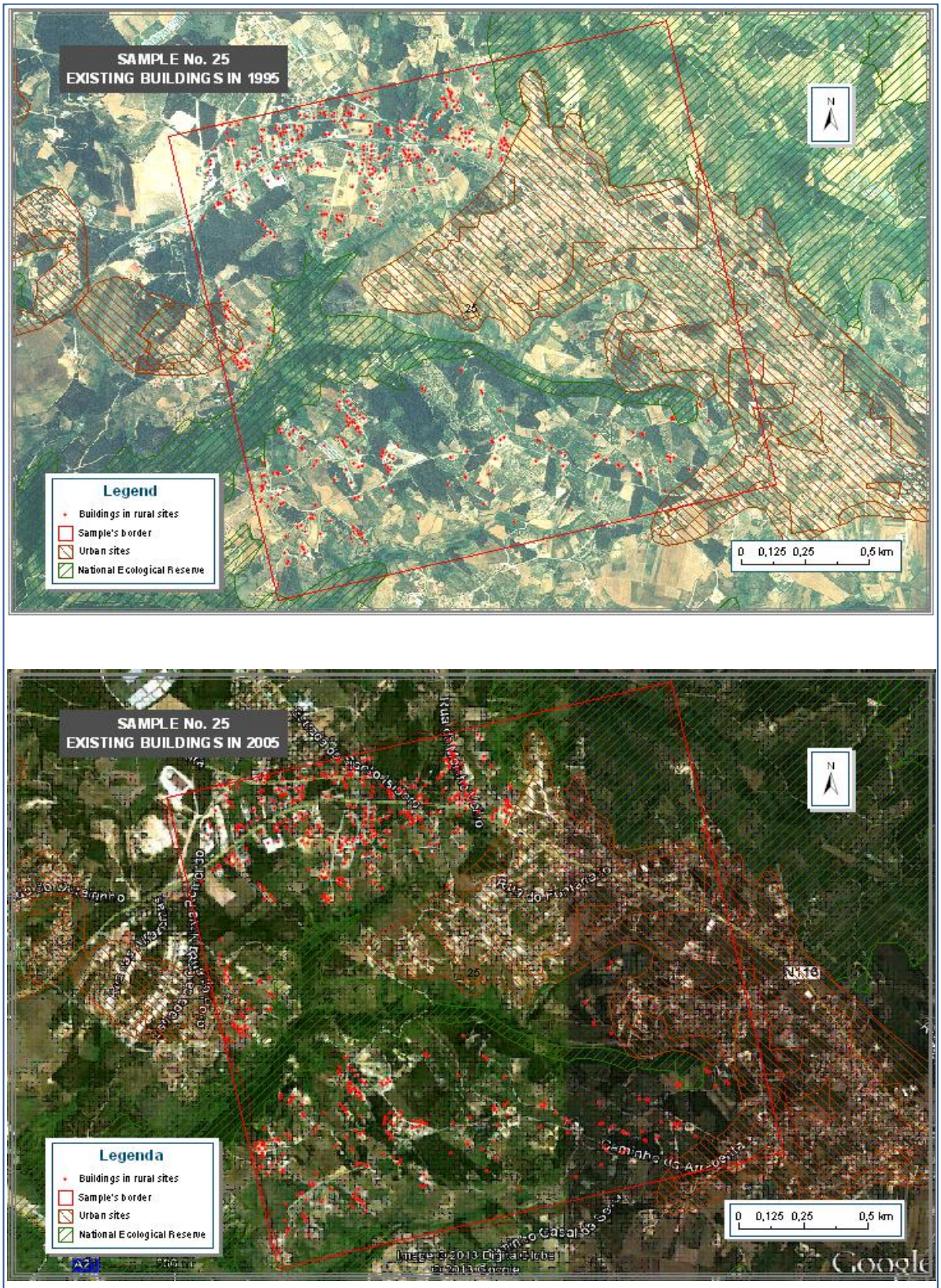

Figure 4 – Variation of the buildings in the peri-urban space of sample No. 25

5. Conclusions

- **The PDM and the alterations verified in rural sites**

Not hall identifield changes to the landscape are directly related to the activities in this environmental; infrastructures that serve urban areas and especially the "mutations"[3] resulting from the introduction of structural urban functions are the cause of more rapid and profound perceived changes, as referred by Raws and Roo (2011, p. 271):

> In peri-urban areas where development is induced by dynamic blend of rural and urban processes, change rarely has a single cause, instead, structural change can be seen as an evolutionary process with contextual conditions, playing an importante role.

Many of these transformations assume a pathological character, as they dond't result of a required, gradual and programmed advance of urban upon rural sites. This is supported by DGOTDU, UA and UE (2011, p. 217) "(…) In contrast to other European models, particulary the English, in which the suburb was born out of a desired and planned reality, the Portuguese developed peripheries lie on the side lines of planning. (…)".

The surveys addressed to the buildings in the six samples (Table 9) showed a large difference in densities between samples buildings located in Mafra and the rest. Moreover, also the variations in each sample are higher in Mafra than in any other, although in percentage terms this does not appear to be true. The fact is Montijo and Palmela have a much smaller number of buildings, which represent a deviation in the meaning of the respective percentage.

SAMPLES		BUILDINGS (un)			
		EXISTING		VARIATION	
No.	LOCALIZATION	1995 (un)	2005 (un)	(un)	%
5	Montijo e Palmela	2	3	1	50,0
7	Mafra	315	373	58	18,4
12	Palmela	164	181	17	10,4
25	Mafra	447	558	111	24,8
28	Montijo e Palmela	39	40	1	2,6
36	Mafra	243	301	58	23,9

Table 9 – Summary of the buildings in the samples

The samples showed a clear division the dynamics of transformation between the North of the Tagus and the South. Given the similary of the indicator of permissiveness among the three municipalities covered by the sampling (Mafra, 0,64; Montijo and Palmela, 0,68), the irrelevance of the influence of PDM in the genesis of differences between group of samples is evident.

On the other hand, the differences shows a strong connection between changes recorded and location factors because the former includes residual areas between urban spaces, in which peri-urbanization is patent, while the southern, more distant from large clusters, has its rural landscape better preserved.

[3] Towards loss of rural identity.

- **Goal fulfillment**

Despite the similary between the indicators of permissiveness of the three sampling targets municipalities, peri-urbanization only manifested itself in samples north of the Tagus, which was induced by factors of attractiveness listed on the analysis of photographic records. Despite being the least permissive, the regulations of buildable rural subspaces in Mafra have not hampered the profusion of construction during the study period.

Although the samples have been subject to a similar level of regulatory permissiveness, in the south of the Tagus, there were no perceivable changes associated with the phenomenon of peri-urbanization, leaving notice the lack of attractiveness that these territories have for occupancy with urban functions.

The PDM is not actually responsible for the dynamic differences between the Mafra samples and the remaining, but the same can not be said when individually assessing this influence. This happens because in each of the samples located in Mafra, the PDM had a decisive influence on the transformation of the urban fringe, as its high building permissiveness in rural sites enabled the proliferation of new buildings attracted by the location factors. In the samples at south of the Tagus with levels of permissiveness slightly higher, there were not similar developments, mostly due to the lack of initiatives induced on low-interest location factors.

Thus it appears that the regulations of the PDM from the municipalities of AML decisively influenced the process of suburbanization, not as anchors, but as instruments of allowance of the changes registered.

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