Urban perimeters issues in low-density areas

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Abstract. In the domain of spatial planning, there is a concern to preserve the territory whilst ensuring a proper expansion of urban perimeters. Cities, towns and villages should be contained within urban perimeters for building and urbanization purposes. The concept of urban perimeter is defined as the closed polygonal line demarcating the continuous territory of urban land-use. The spatial planning instruments should define the urban land-use referring to areas totally or partially urbanized or built. Regarding low-density territories with a greater propensity to urban sprawl and population ageing, the previously mentioned rules are not always met. Thus, this study focuses on the case of the Interior region of Portugal classified as low-density territory. Here the number of inhabitants is decreasing with low demand for urban spaces. However, the urban perimeters were mainly defined without being based on territorial features, topographic mapping or ecological sensitive areas. Thus, for a diversity of aspects, there are inappropriate areas to build that were wrongly included as part of urban areas, creating as a result urban void. One main reason for this problem are the topographic conditions that don’t fit with the urbanization and building requirements in urban perimeters. In this sense, this research aims to describe the articulation between the urbanization and building processes, under the rules of the Municipal Master Plans, regarding the topographic features of urban perimeters. The conclusion shows that the most sloped areas are those that were less sought after for urbanization, however these zones comprise a significant part of the urban perimeters. Finally, there is the need to stress that in low-density territories, many urban voids will never be urbanized.

1. Introduction

The Municipal Master Plan is the main spatial planning instrument in Portugal on behalf of local authorities. In a country with 308 municipalities, the majority has adhered to the master plan version of the 1990s. These rules have established that the urban perimeters were composed of the set of consolidated urban spaces, urban development areas and industrial land-uses. The definition of consolidated urban areas was based on a high level of infrastructures, diversity of activities and central functions, as well as demographic density. However, the results of this process were not always based on the satisfaction of all the stakeholders, inhabitants, urban developers and investors, builders and political decision-makers [1]. In fact, this experience was based on the formalization of urban solutions and regulatory urbanization and building standards aimed at ensuring a coherent and sustained development strategy for the municipal territory. However, this process was insufficient to fully comply with the previously referred goal, caused by several circumstances, in particular the urgency with which these plans were drawn up. At the time, the local authorities had to have the master plan ready in a short period of time, to obtain European Union funding. Therefore, the urbanization process occurred with the lack of technical and human resources of the municipalities, along with the weakness of knowledge.
of urban reality, or deficient cartographic data. Regarding low-density areas with population ageing, deflation of territories by people and activities, low levels of income, scarcity of spatial planning instruments, or delays in updating their contents, these problems become even more serious. In this context, this article will be focused on the low-density territory of the Interior region of Portugal, studying seven pivotal case studies (Almeida, Belmonte, Celorico da Beira, Figueira de Castelo Rodrigo, Média, Pinhel and Trancoso), given that their master plans are still from the 1990s, without having any updating. Thus, their contents are absolutely outdated regarding territorial reality in general, and in particular the urban perimeters dynamics. The methodological approach comprises the following steps: 1. Study of demographic evolution in low-density areas; 2. Data collection of the municipal master plan; 3. Analysis of results in the case of Belmonte urban perimeters.

2. Study of demographic evolution in low density areas

There is no unambiguous definition for low-density urban areas, as they vary from country to country. For example, in The Netherlands there are studies [2] considering that low-density areas have no more than 200 inhabitants per km². Although there is no legal classification in Portugal for low-density areas, reference is made [3] using multiple criteria which consider population density, demographics, urban and rural settlements, territorial features, and socio-economic factors of each region. At the 165 municipalities of the continental part of the country, 57% of them are low-density areas, mainly (figure 1) in the Interior region, near to the border with Spain, and further away from the Atlantic and Mediterranean sea shores. Among the 114 municipalities (including the case studies) of the Central region [4] 73 of them (corresponding to 64%) are considered as low-density areas (figure 2).

| Table 1. Demographic indicators at the case studies (2011-2018). |
|---------------|----------------|----------------|----------------|----------------|---------------|----------------|
|               | Population     | Position       | Population     | Population     | % Municipality |
|               | Density        | (among 308     | Number         | Density        | population     |
|               | municipality   | municipalities)| (urban area)   | Urban Area     | living in the  |
|               | (inh./km²)     |               | 2011           | (km²)          | main urban area|
| Almeida       | 14             | 11,4           | 274            | 278            | 1314          | 1,72           | 763            | 18,1 |
| Belmonte      | 57,8           | 53,9           | 171            | 172            | 3183          | 2,74           | 1162           | 46,4 |
| Celorico da Beira | 31,1       | 28,2           | 218            | 221            | 2278          | 4,14           | 550            | 29,6 |
| Figueira de C. Rodrigo | 12,3   | 11,1           | 285            | 283            | 2211          | 2,29           | 966            | 35,3 |
| Média         | 18,2           | 16,1           | 256            | 257            | 1987          | 2,37           | 838            | 38,2 |
| Pinhel        | 19,9           | 17,8           | 249            | 250            | 3518          | 1,11           | 3169           | 36,5 |
| Trancoso      | 27,3           | 24,7           | 233            | 234            | 3289          | 2,04           | 1612           | 33,3 |

The results of demographic indicators show (table 1) that in all case studies there is a decline of the population density (2011-2018) at municipal level. This decline was lower in Figueira de Castelo Rodrigo (from 12 to 11 inh./Km²) and higher in Belmonte (from 57 to 53 inh./Km²). However Belmonte is the case with the highest density of population among all, followed by Celorico da Beira (28 inh./Km²) and Trancoso (25 inh./Km²). All the others are below 20 inh./Km². At national level, Belmonte registers the best position (172) among the 308 municipalities regarding this indicator. The other six case studies
belong to the lowest 100 cases of the country. This demographic indicator has gotten worse in the majority of them, except at Figueira de Castelo Rodrigo passing from position 285 to 283. This means that they are among the lowest density territories all over the country with no hope of changing this situation. A deeper analysis at the urban scale shows that Pinhel is the case with the highest density 3169 inh./km$^2$ in terms of population, and Celorico da Beira has the lowest density with 550 inh./km$^2$. The town of Belmonte (the main urban area in this municipality) is the case that attracts the highest number of residents from all over the municipal territory, 46.4%, followed by Média (38.2%), Pinhel (36.5%), Figueira de Castelo Rodrigo (35.3%), Trancoso (33.3%) and Celorico da Beira (29.6%). Finally, in Almeida, less than $\frac{1}{5}$ (18.1%) of the municipality population is living in its main urban area (the city of Almeida). Vilar Formoso is the urban area of the municipality of Almeida which attracts more residents (31%) because it is an international border post.

The demographic indicators place Portugal as one of the most aged countries in the world, with the elderly being a socially vulnerable group, that experience gross social neglect, reflected in people’s lives [5], having influence on the real estate market, and consequently on urban areas [6] Demographic cycles regarding births, migration, families formation and dissolution, disability and death influence housing demand [7-11]. There is a close relationship between the ageing process and the reduction in demand for new housing [12]. In a young population the demand for housing is high due to the flow of new households, but in an ageing population, there is a low demand for housing due to the decline of households with the death of the elderly [13], [14]. The demographic analysis of case studies reveals a marked ageing through the increasing weight of people over the age of 65 years old, with a reduction in the young people. The rate ageing refers to the number of residents with 65 or more years of age per 100 inhabitants under the age of 15 years old. The urban area of Almeida has a rate of ageing of 320 which is the highest value among all case studies, followed by Celorico da Beira with 184, as well above
the national average of 176. The least aged urban area is Pinhel with 133 and Figueira de Castelo Rodrigo with 136, both of them below the national average.

Figure 3. Ageing index at the case studies (2011)
Alphanumeric data source based on www.ine.pt

The case studies have been no strangers to the population decline. Their location in the Interior region, furthest from the major cities, has marked this trend of population decline for several decades. Demographic projections indicate an unprecedented regressive population dynamic in their history. The population in six urban areas (2011) did not exceed 3500 inhabitants and only Pinhel exceeded this value with 3518 residents (figure 3). They are all urban areas with a demographic deficit and a tendency to reduce these values in future times. Trancoso has a continuous loss, increasingly severe, year after year, since at least the beginning of this century (table 2), registering 5% less in 2001, 10% less in 2011 and 11% less in 2019. Belmonte, Celorico da Beira, Figueira de Castelo Rodrigo, Mêda and Pinhel have had a similar performance. However, in the last decade (2011-2019) the pace of loss was a bit less accelerated. Almeida is the case with a deepest population loss, registering 24% less people in the last decade. The case studies have a population loss of 30% on average (2001-2019), Almeida has the highest value with 42% and Belmonte has the lowest value with 14% less people. The population natural growth rate, which corresponds to the difference between the birth rate and the mortality rate (figure 4), was negative in all case studies in the order of -1.20% as average. Belmonte registers the least negative value of -0.72% and Almeida has the most negative order of -2.30%. Despite all cases show negative demographic indicators, Belmonte is in the better situation and Almeida in the worse.

Table 2. Population evolution (1991-2019) in the case studies
Alphanumeric data source based on www.ine.pt
3. Data collection of the municipal master plan

The chosen urban areas (figure 5.a) are on the top of the hierarchy network in the Interior region. Theoretically, urban areas refer to the spatial extent of the most broadly defined urban land-use, i.e. the area within the administrative boundaries of a city, including all the impervious surfaces, vegetated areas, barren land and water bodies. In the case of multiple cities, urban area is the total sum of urban areas of all the cities in the region [15-18]. The urban areas under analysis are considered pivotal examples, based on the following indicators: population ageing for six decades; a deflating of territories by people and activities in the smaller towns, villages or rural settlements; low-density in terms of population and housing; low levels of economic income of the families; scarcity of spatial planning instruments. In all of them the municipal master plan from the 90s is the only existent planning instrument, that has been in effect for at least 20 years. It is a regulatory instrument that “can have both positive and negative effects in the construction of urban sustainability” [19]. Due to delays on the master plans updating process in all case studies, their rules do not match reality and are completely out of step with contemporary territorial challenges. The urban perimeters of Almeida, Belmonte, Celorico da Beira, Figueira de Castelo Rodrigo, Mêda, Pinhel and Trancoso, have a resident population in common between 1314 (in Almeida) and 3518 (in Pinhel) inhabitants (Table 1). The years of entry into force of their master plans are the following: two of them are from 1994 Almeida [20] and Trancoso [21], four are from 1995 Celorico da Beira [22], Figueira de Castelo Rodrigo [23], Mêda [24] and Pinhel [25] and Belmonte is the most recent from 1996 [26]. Considering the central region of Portugal [4] (figure 5.b) the municipalities of the Interior are those where there is a longer delay in the updating process of the planning instruments. In the seashore municipalities, the majority of the plans were already reviewed, having recent versions with updated data, and their contents are more likely to fit with territorial needs.
The urbanization process based on the construction sector is influenced by economical, geographical, social and environmental issues. The analysis considering the number of new buildings for almost a century (1919-2011) reveals the following two tendencies (table 3):

- In the urban areas of Almeida and Mêda the number of new buildings has been steadily increasing. This fact could be a problem in spatial planning and urban requalification terms, given that the population has been decreasing. Therefore, a great number of these buildings are empty, with no one living there;
- In the remaining cases the number of new buildings was increasing until 1990, since then it has decreased, following the population loss (figure 6).

**Table 3.** Number of buildings per time of construction in the county headquarters, case studies. Alphanumeric data source based on www.ine.pt

| Urban area                    | 1919 | 1945 | 1976 | 1970 | 1971 | 1990 | 1991 | 2011 |
|------------------------------|------|------|------|------|------|------|------|------|
| Almeida                      | 3    | 50   | 341  |      |      |      |      | 374  |
| Belmonte                     | 121  | 333  | 662  |      |      |      |      | 373  |
| Celorico da Beira            | 136  | 259  | 346  |      |      |      |      | 345  |
| Figueira de Castelo Rodrigo  | 104  | 247  | 449  |      |      |      |      | 335  |
| Mêda                         | 125  | 190  | 342  |      |      |      |      | 398  |
| Pinhel                       | 88   | 265  | 682  |      |      |      |      | 605  |
| Trancoso                     | 164  | 201  | 674  |      |      |      |      | 634  |
4. Analysis of results in the Belmonte urban perimeter

In the case of Belmonte, it is observed that part of its urban space, included in the land-use map of the Municipal Master Plan remains without any type of urbanization nor construction. Consequently, there are urban voids, which in this particular, are the result of topographic conditions, especially spotted in areas defined for urban purposes, but with steep slopes, with absolute underuse of existing infrastructure. This medieval urban settlement, with historical roots in the early 11th century, has as its main landmark, a castle on top of the hill. In these areas, with required land movements in order to allow the urbanization works or the stabilization of embankments, the price to pay is too high, discouraging any building action, due to a total absence of urban developers and builders. The cause for this lack of interest was precisely the physical, morphological and ecological characteristics of this territory. The rugged topography (at least 12% slope) turned out to be absolutely unfavourable to any claim for urbanization or building. This problem turns even more serious in a municipality of the Interior of the country where there is a demographic decrease since decades ago. It’s consolidated urban fabric is between 500 and 550 meters high, where the topographic conditions are most severe. The urbanization and the construction developments were less intense in the most sloped areas [26]. This result couldn’t be seen as a surprise, however, the novelty is driven by the fact that the majority of its urban area refers to very steep spaces, where the urbanization and construction actions have been too expensive for local budgets (public and private sectors). The mapping of topographic conditions of Belmonte [27] is based on the following five sloping levels (table 4):

- [0-2%] is considered as the average topographic condition level for urbanization purposes. In the case of Belmonte it corresponds to 12 ha i.e. 4 % of the urban perimeter as a whole. Five of them are in consolidated urban areas and seven of them are in the area of urban development purposes;
- [2-3%] is considered as a very good topographic condition level for urbanization. In Belmonte it comprises 9 ha i.e. 3% of the urban perimeter. Three of them in the consolidated urban area, and the remaining six hectares in the space for urban development purposes;
- [3-5%] is considered as a good topographic condition level for urbanization. It corresponds to 68 ha of the urban perimeter of Belmonte i.e. 25%. 19 ha in the consolidated urban space and 49 ha in the urban development purposes;
- [5-8%] is referred to as a bad topographic condition for urbanization. It corresponds to 112 ha i.e. 41% of the urban perimeter of Belmonte. 43 ha are in the consolidated urban space and 69 ha in the urban development purposes;
- [8-12%] is referred to as a very bad topographic condition for urbanization, corresponding to 71 ha i.e. 26% of the urban perimeter of Belmonte. 26 ha are in the consolidated urban space and 45 ha are in the urban development purposes space.

Figure 6. Number of new buildings in the urban areas. Alphanumeric data source based on: www.ine.pt
This analysis demonstrates that there are two topographic levels that don’t fit with the urbanization and building requirements, being considered unfavourable for urbanization and construction purposes, the level 5-8% and the level 8-12%. In Belmonte, the most steep places considered unfavourable for urbanization are occupying the largest area of its urban perimeter. The slope level of 5-8% is the most representative in Belmonte with 41% of the urban area. It is followed by the slope zone of 8-12% with 26%. Summarized, above a level of 5% the topographic conditions are not recommended for urban purposes. As the literature refers, there are several difficulties for urbanization due to the steep slopes. For example, in relation “to streets it is advisable to use (...) the (...) half slope to the structural network (its inclination should not (...) exceed 8% and may reach exceptionally 16%)” [28]. Therefore, these places when related to new urban development areas, shouldn’t be included as part of urban perimeters. Unless there are particular situations, such as a budget for doing so, a high pressure in terms of population growth, a high level of demand for urbanization and construction, or a scarcity of other alternative spaces. None of these particular situations are present in the studied low-density territories.

In between 2012 and 2018 (figure 7) there were only 21 urbanization and building operations, regarding a population of 3183 inhabitants living in Belmonte urban area. All of them took place in 2017 (figure 8), the majority (70%) in the consolidated urban area, and 30% at the urban development purposes space.

![Figure 7. Slope plant in the urban perimeter of the village Belmonte.](image)
Cartographic data source: AMCB scale 1:2 000

![Figure 8. Urban operation in the village of Belmonte.](image)
Cartographic data source: AMCB scale 1:2 000
Alphanumeric data source: Belmonte City Council

| Classes of slopes | Urban space (hectares) | For urban purposes (hectares) | Σ (hectares) | % |
|-------------------|------------------------|------------------------------|--------------|---|
| 0-2%              | 5,19                   | 6,64                         | 11,83        | 4,32% |
| 2-3%              | 3,20                   | 5,92                         | 9,12         | 3,33% |
| 3-5%              | 19,03                  | 48,97                        | 68,00        | 24,84% |
| 5-8%              | 43,36                  | 69,87                        | 113,23       | 41,37% |
| 8-12%             | 26,50                  | 45,04                        | 71,54        | 26,14% |
| Σ=                | 97,28                  | 176,44                       | 273,72       | 100,00% |

Table 4. Classes of slopes in the urban perimeter of Belmonte due to urbanization process.
5. Conclusions
The analysis of the seven low-density urban areas of the Interior region of Portugal, reflects a sharp decrease in the population of about 30% in the last 30 years, reflecting their ageing and decrease in younger age groups. It was also found that the steepest areas, with slopes above 5% are those that were less sought after for urbanization. As demonstrated by the slope map of Belmonte more than 40% of its urban perimeter is in the class between 5 and 8% slope, considered unfavourable to the urbanization process. Therefore, it should be put out of the urban perimeter in the future planning instruments, if not yet urbanized. In this sense, one of the most urgent measures is adapting urban perimeters to topography. This knowledge will make it possible to ascertain which of the spaces within the urban perimeter in steep slopes have effectively been urbanized, and which remain waiting, as urban voids. However, in a territory of the Interior of the country, with recessive demographic tendencies, the existence of urban voids is a factor that does not contribute to qualifying urban spaces. In order to ensure the continuity of the urban fabric and the use of existing infrastructures, urban voids, whenever possible, should be excluded from urban perimeters. The ongoing revision process of the master plans is the opportunity for this to take place. To this end, a joint approach is suggested to link demographic projections with urban voids and also with aspects such as buildings that are vacant or in ruins in the consolidated areas of urban settlements. One of the most urgent steps, regarding the difficulty of reversing the recessive demographic trends of the low-density regions of the Interior of the country, is the return to the rural land-use of the urban voids currently included in urban perimeters. Therefore, they should be excluded from urban perimeters during the Municipal Master Plan reviewing process, which will result in a shrinking of urban perimeters, more adequate to the real territorial and demographic features. In this way, there is the need that urban perimeters reflect the local reality in favour of urban continuity and sustainability.

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