

# Assessment of the Effects of the Expansion of the City of Estarreja on the Rational Land Use

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**ABSTRACT:** The management of urban environment, together with the preservation of the natural environment and the creation of a sustainable built environment, is a complex challenge for contemporary societies. In the name of progress, cities are contributing for the degradation of all surrounding ecosystems. Therefore there is an arising demand for developing new strategies and a new urban development paradigm settled in the search for the equilibrium between natural and built environments and efficient use of resources. The objective of this paper is to analyse how the urban expansion of the city of Estarreja took place in relation to the land use, based on the land capability classification maps of the area. Based in the results some sustainable development strategies that might be applied to the city are discussed. The obtained results demonstrate that the city has been growing faster than its population, consuming vast portions of land, since its growth has been occurring in a linear form. Despite this fact, results show that most of this expansion took place towards a territory of lower agricultural potential, when comparing to the location of its original settlement.

**Keywords:** sustainable urban development, urban sustainability assessment, rational land use.

## 1 INTRODUCTION

Scarcity of space is rising, in an increasingly urbanized world. In Europe, despite a general shrinking population, soil sealing and land consumption is still increasing (Artmann, 2014). Urbanisation and urban growth are inevitable and unavoidable anthropic processes of land use change. The rational land use, based on its ecological potential, is therefore critical to the sustainability of urban areas. In Europe, urban sprawl is considered critically important due to its evident impact on increased energy, land and soil “consumption”. Urban sprawl has been the cause of uncontrolled urban expansion over agricultural areas; as opposed to traditional European cities, which are compact cities, sprawling cities are full of empty spaces that indicate the inefficiencies in development and highlight the consequences of uncontrolled growth (EEA, 2006). Sprawling is affecting negatively ecosystems functions (EEA, 2006; Alberti, 2005), including the production of food, habitat for natural species, recreation, water retention and storage that are interconnected with adjacent land uses (EEA, 2006). Urban expansion should therefore be based on strategies to minimize its impact on the surrounding ecosystems, ensuring the most basic needs for the people survival and to reduce their ecological footprint.

Ferreira et al. (2012) addressed the problem of defining expansion areas in small urban settlements, applied to the city of Tomar, which is characterized by highly dispersed construction and deficient realisation of the planned expansion areas. The methodology used for this study involved the identification of consolidated urban areas, through the analyses of local building regulations, and then, quantifying urban expansion areas in accordance to different criteria, including size and hierarchical position. The methodology further included a participatory approach, incorporating the knowledge of local politicians. The authors concluded that the methodology used reflects all concerns related with the containment of disperse construction and the goal to consolidate the urban system. To impose heavy restrictions to outskirts settlements could be one way of addressing disperse construction phenomena, which should be complemented by an increased flexibility in the use of urban space. Artmann (2014) conducted a study in which institutional efficient soil-sealing management approaches, strategies and sub-strategies are studied and characterized, contributing to a better understanding of their advantages and disadvantages. Two case study cities were selected in Germany; Leipzig, which represents a shrinking city or city in transition, and Munich, which represents a growing city. These criteria were adopted in order to be possible to consider various challenges of urban soil sealing management. The evaluation was then based on the application of the Response-Efficiency-Assessment (REA) method, using subjective and objective indicators. Strategies of the following type were assessed: legal-planning, informal planning, economic-fiscal, co-operative and informational. The authors concluded that informal planning strategies are institutionally the most effective, due to their flexibility, high acceptance and limited reduction in local authority; however, and due to an increase of soil-sealing and land take in Europe, high local flexibility might need more stringent rules, connected with new economic-fiscal incentives. It is also concluded that new taxes, which among other things can promote the protection of fertile soils, should be implemented. It is finally concluded that local authorities should be more aware of their authority and responsibility to limit soil sealing and ensure a high urban living quality, but the implementation of more stringent rules should always be justified with proof of their effectiveness.

In order to provide its inhabitants with a good quality of life, and leading their cities towards a desired status of urban sustainability, many cities around the world have developed sustainable urban development plans (Shen et al, 2011). Shen et al (2011) conducted a study in which sustainable urbanization practices in the process of selecting urban sustainability indicators were critically examined and compared, being categorized in four different dimensions: environmental, economic, social and governance. Nine different practices, that is, Melbourne, Hong Kong, Iskandar, Barcelona, Mexico City, Taipei, Singapore, Chandigarh and Pune, were examined, proposing subsequently a comparative basis, namely, International Urban Sustainability Indicators (IUSIL). Despite the fact that the studied urbanization plans were by large implemented in order to achieve a sustainability status, they were developed in different time, under different circumstances, and for varied purposes. These factors revealed the difficulties in applying a set of common urbanization indicators, which should be therefore applied considering the specific needs of each location. It is observed that a short list of indicators at the beginning of application is recommended, with the possibility of more indicators being added or eliminated according to the emerging needs and gained experience in individual cases. It is arguable that proposing a set of objectives and strategies can be applied indistinctly in all communities. On the other hand, sharing experiences might eliminate barriers that lead to the maturity of sustainable urbanization as a common practice. The authors concluded finally that having a comparative basis can lead to the development of standard processes, which can be used to guide the development of particular plans, selection of indicators, objectives and strategies for implementing sustainable urbanization practice in other communities.

## 2 OBJECTIVES

The objectives and expected results for the present study are to understand how the city of Estarreja expanded over the last 50 to 60 years and its effect over the rational land use, particularly on the land with agricultural potential or other ecological interest. This is aimed to: i) understand how Estarreja's future urban expansion or regeneration processes can optimize the use of endogenous resources; ii) define local strategies for sustainable urban planning; iii) and to improve and promote "green infrastructures" as sustainable elements and demonstrate their importance on urban planning as a functional element and not only as an aesthetic improvement.

## 3 METHODOLOGY

The research was developed based on the analysis of some cartographic information, such as the Municipal Mater Plan, Municipality of Estarreja (CME, 2014), historic plans (CME, 1979; Mendonça, 1954) and Portuguese land capability classification system for soils (DGADR, 2010). The several layers of information collected allowed highlighting some relevant data for the study, which included the location of the municipality settlements and Estarreja's urban expansion through time, in relation to various geographic features, including altitude/relief and potential agricultural land. In turn, this information allowed the identification of Estarreja's urban expansion problems. According to the results obtained, alternative strategies were then presented, which by its implementation may allow the optimization of the use of endogenous resources and allow the sustainability of Estarreja's communities.

## 4 USE OF THE LAND IN THE CITY OF ESTARREJA (LAND CAPABILITY CLASSIFICATION)

The municipality of Estarreja spreads over an area of approximately 108 Km<sup>2</sup> (IGP, 2009, cited in Pordata, 2015), ranging from an altitude of 0 to 129 meters above sea level (IGP, 2009, cited in Pordata, 2015). Its population represents about 9% of the population of Baixo Vouga region, where is located, constituting the fourth most populous municipality in a total of twelve (CME, 2012). The importance of the municipality and city of Estarreja is given mainly by a strong industrial presence, where the second most important chemical complex of Portugal is located (AIP-CCI, 2011). It is also located in Estarreja's industrial zone one the most important units related to milk and derivates production (AIP-CCI, 2011). Being divided in three distinct zones: low, intermediate and high (CME, 2012), it is in the intermediate zone, between 5 and 50 meters high, where most of Estarreja municipality built areas are located (Fig. 1). This zone does not have any considerable slopes, especially the territories located in the north of the Antuã river, where the land is mostly flat, and does not have the drainage problems verified in the lower zones (CME, 2012). Additionally, in terms of land capability classification, Estarreja municipality settlements are located over, or very close to the best agricultural lands, i.e., capable for intensive or moderately intensive agricultural use, with the exception of the parish of Veiros, which is located over an area with lower agriculture potential (Fig.2).

Occupying a central position relatively to the entire municipality, the city of Estarreja is located on the northern bank of the river Antuã. This is the most important watercourse in the municipality, forming a valley to the east where the steepest slopes are located (CME, 2012). Nevertheless, the city is located over a flat part of the territory, which corresponds to the intermediate abovementioned zone (Fig.1). In terms of capability classification of soils, and as most of the settlements in the municipality, the city has been placed over a land moderately capable for intensive agricultural use (Fig.2). Historically, in the last 60 years, the expansion of the city of Estarreja was from the south to the north (Figs. 3a, b, c, 4). This fact is explained by the presence of the Antuã river in the south, and also by the existence of near to sea level altitude lands, more vulnerable for flooding. The expansion of the city has mostly taken place alongside the existing roads and railway, enabling the connection of the city of Estarreja to its

economic/industrial area, to Pardilhó and Avanca, and to the northern neighbour city of Ovar (Fig.4), corresponding this latter connection to a peri-urban axis structured by the national road EN 109 (AIP-CCI, 2011). A minor tendency of expansion has also been noted to the west, in the direction of Veiros, and to the east, in the direction of the smaller villages of Santo Amaro and Beduído (Fig.4). In terms of agricultural potential use, the expansion of the city of Estarreja took place towards a territory of lower agricultural potential, when comparing to the location of its original settlement. We can also note that the economic/industrial area of the city is located in an area with no potential for agricultural use, except in very special cases (Fig4). Nevertheless, a vast extension of the territory has been consumed for urban purposes by the city of Estarreja, since its expansion has occurred mostly in a linear form (CME, 2012), i.e. along side the existing land communication routes, as mentioned above. This is in fact one of the main characteristics of the municipality’s settlements, with the exception of the central areas of the city of Estarreja and few other villages, where the built areas are found to be more compact (CME, 2012). In a broader way, this linear expansion can be compared to the concept of “urban sprawl”, defined by the EEA (2006) as being “synonymous with unplanned incremental urban development, characterized by a low density mix of land uses on the urban fringe”. In the case of Estarreja, this tendency for linear expansion or “sprawling”, may also be explained by the typology of houses being built in the municipality, ranging from 1 to 2 storeys, representing since the 1960 national census over than 95% of the existing buildings (Fig. 5).

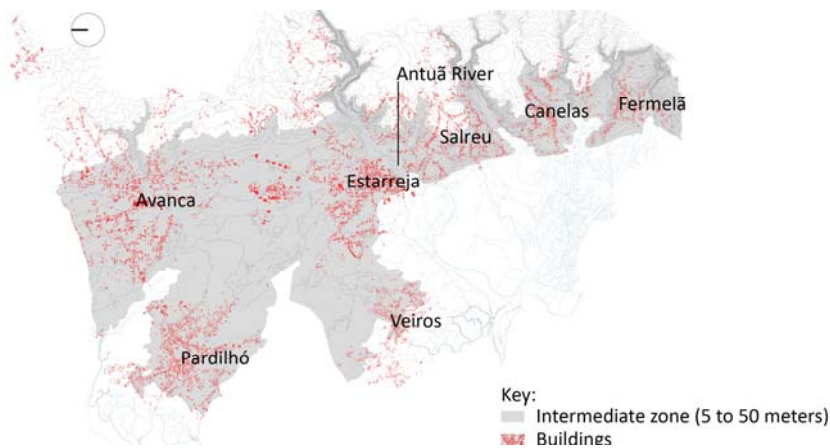


Figure 1. Occupation of the territory according to altimetry (source: CME, 2014).

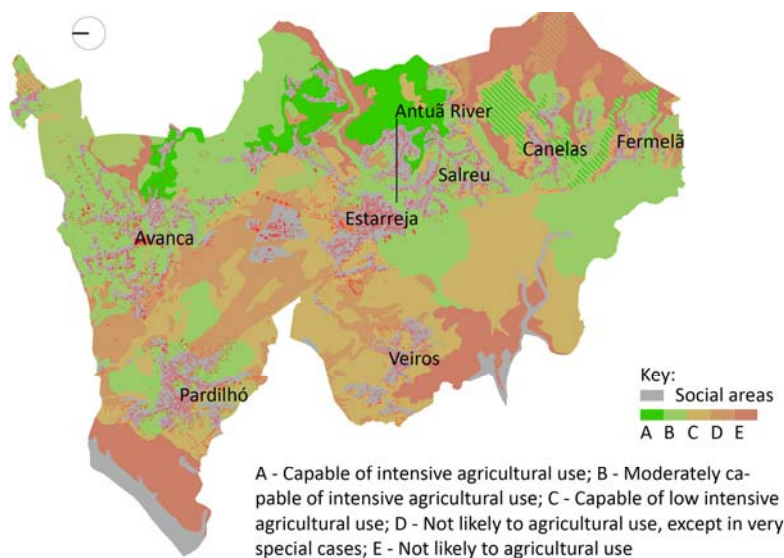


Figure 2. Occupation of the territory according to the land capability classification (sources: CME, 2014; DGADR, 2010).

An attempt to contain the uncontrolled expansion and sprawling of the city of Estarreja has been done in the Municipal Master Plan of Estarreja (PDME), by identifying consolidated urban areas and classifying them as urban land, as well as proposing a ring road, external to the city, that may serve as a barrier for further short-term unplanned expansion (Fig.6). Restricting the physical expansion of the built-up areas is considered by the EEA (2006) as a critical effort to constrain urban sprawl. Despite this fact, a lack of planned expansion areas has been identified in the Municipal Master Plan of Estarreja (PDME) (Fig.6), with only two areas planned, being one located within the identified consolidated area of the city, and the other, a small economic/industrial area, located in between the national motorways A1 and A29. In the latter case, the area corresponds to a portion of the territory with moderate capability for intensive agricultural use, the second best level in the scale (Fig.6).

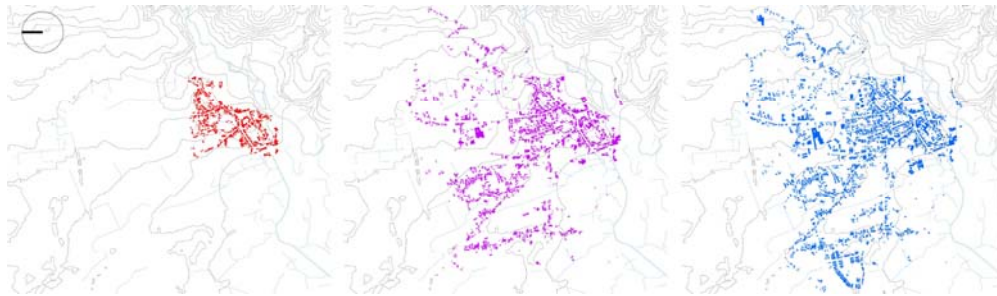


Figure 3. Estarreja urban expansion (1954, 1979, 2013) (sources: CME, 2014; CME, 1979; Mendonça, 1954)

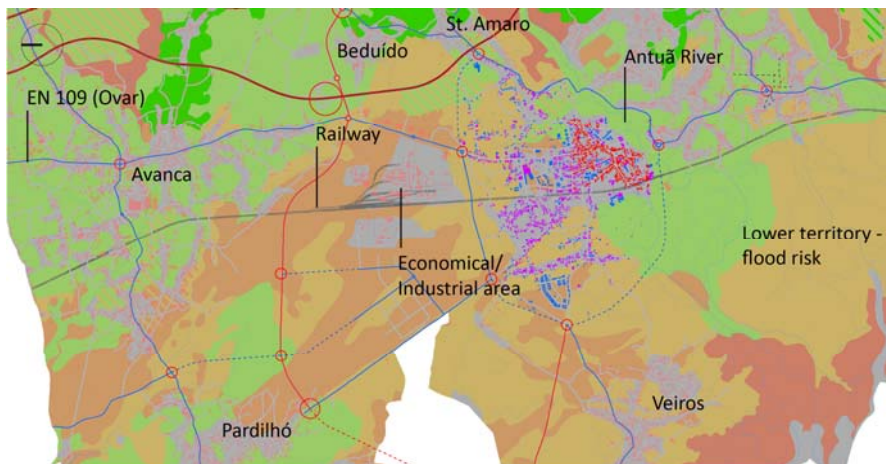


Figure 4. Urban expansion according to the land capability classification (sources: CME, 2014; CME, 1979; Mendonça, 1954; DGADR, 2010)

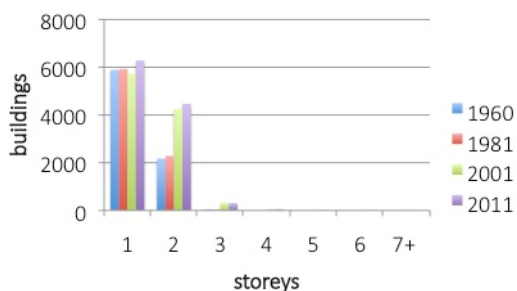


Figure 5. Existing buildings according to the number of storeys (source: INE, n.d., cited in Pordata, 2015)

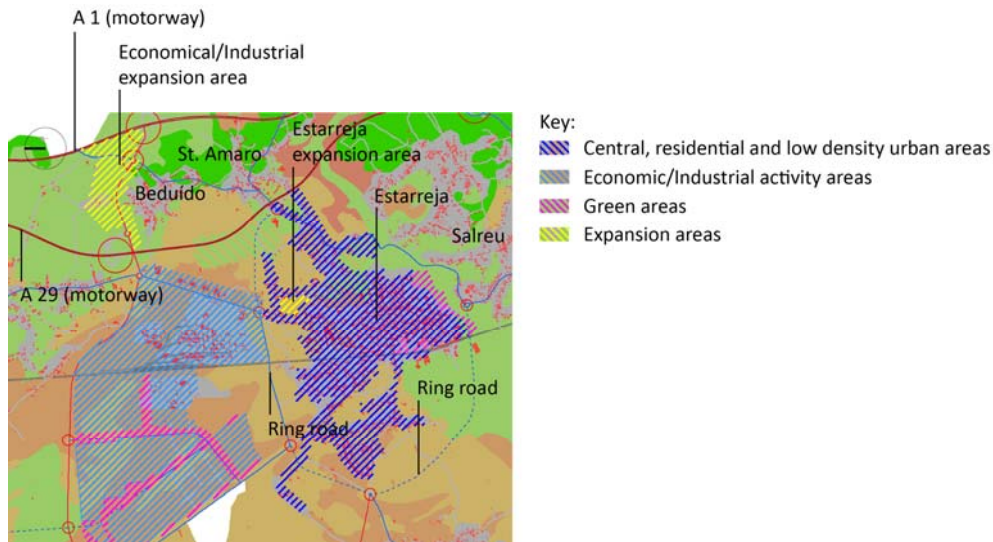


Figure 6. Urban expansion according to the land capability classification (sources: CME, 2014; DGADR, 2010).

## 5 CONTRIBUTES FOR THE SUSTAINABLE DEVELOPMENT OF THE CITY OF ESTARREJA

The fast pace in which cities grow may result in many ecological problems (Matteucci et al, 2009), often at the expense of the loss of valuable ecosystems (Shen et al, 2001). In 2001, Albernethy already considered that the fast inflows of rural dwellers, and consequent increase of urban population would cause inevitably numerous challenges to the destination cities (Albernethy, 2001). Sustainable urban development is therefore crucial to secure prosperity to our cities and societies, being sustainability the core of scholarly discussion, boost by a rapid industrialisation and urbanisation (Yigitcanlar et al, 2014).

Despite the existence of extensive natural or semi-natural landscapes in Europe, in 2006 more than a quarter of the European Union territory was been directly affected by urban use (EEA, 2006). Additionally, approximately 75% of Europe’s population is living in urban areas (EEA, 2006). The same report predicted the increase of the European urban population between 80% to 90% by the year 2020. Portugal is no exception; larger settlements, i.e. cities and towns, have been concentrating more population when compared with the smaller rural villages (Conde, 2007). Given this fact, and considering that cities are the biggest consumers of natural resources and simultaneously the biggest source of pollution and waste (Madureira, 2005), it seems necessary that principles of sustainable development should be applied to cities, as these are the territories where these principles will have a greater impact (Costa, 2000). Elmqvist et al, (2013) consider urban sustainable development an urgent need to face the problems of contemporary cities.

In 1972, the problematic or concept of “sustainable development” was addressed by Meadows et al. (1972), by analysing the basic factors that could limit societies growth and development: population, agricultural production, natural resources, industrial production and pollution (Meadows et al, 1972). Originally centred within the scope of the natural environment (Abiko et al, 2009), the discussions about new and more sustainable forms of development have been gradually addressed and applied to the urban environment (Madureira, 2005). In 2004, Maclaren distinguishes the concepts of “urban sustainability” and “sustainable urban development”. The author considers the latter as the process from which it is possible to achieve a set of desirable conditions: environmental, socio-economic, political and cultural, that persists over time i.e., “urban sustainability” (Maclaren, 2004).

According to Madureira (2005), a significant part of the debate about sustainable urban development has been based on the search for the best “urban shape”. Considered by Sassi (2006) “one of earths most precious resources”, land is not only the physical support for urban

environments but also for natural environments and should therefore be used with parsimony. The intensive use of land for urban purposes, transforming forest or agricultural areas into areas for settlement or transport, can be therefore considered one of the big problems of the contemporary city. This kind of land take or land consumption can be closely related to soil sealing, and interventions to reduce it are needed, as soil sealing has become one of the most intense form of land take (Prokop et al, 2011).

Historically, European cities have been much more compact than today, characterized by a dense historical core, which was shaped before the emergence of modern transport systems; their growth was usually linked to increasing population, in contrast with modern urban sprawl, usually linked to individual housing preferences, increased mobility or commercial investment decision (EEA, 2006). Being urban sprawl a common phenomenon in Europe today, it increases energy, land and soil consumption (EEA, 2006). In 1990 the Green Paper on the Urban Environment appointed already the growing trend for extensive and indiscriminate urbanisation and land use policies, based on restrictive and mono-functional zoning, as the main problems of the cities and these characteristics are an obstacle for the needed urban sustainable development. Sassi (2006) considers that the potential advantages of compact cities are: efficient land use; protection of the natural landscape; access to culture and leisure facilities; access to commercial facilities; employment opportunities; access to transport; potential for district heating and efficient recycling (Sassi, 2006).

The urban growth of the city of Estarreja should therefore be considered in a more compact urban form, as traditional cities have been shaped in Europe. Despite being a small city, its historical core, more dense and compact, can be clearly identified in contrast with its linear expansion or "sprawl". Its zones of linear expansion can be transformed into a more compact and dense form, associated to its historical core. A clear border to further uncontrolled expansions can be created, as well to encourage the construction of multifamily housing buildings, with commercial or services occupancies associated, built together with the existing one or two floors single family housing buildings. This way not only the density can be increased, but at the same time, it is possible to avoid the concept of zoning. This concept was been overtaken by the concept of mixed-use, where working, leisure and living are as close as possible (Sassi, 2006).

In Estarreja, and despite the fact that the population has decreased in the last few years, the number of existing buildings has been increasing (Fig. 7). It is therefore crucial that the expansion is initially based on the use of "brownfield" land or vacant plots and on the rehabilitation or reconstruction of existing abandoned buildings. The priority to the rehabilitation or reconstruction of existing buildings will constitute a very important policy since, at the moment, these types of urban operations are in very small number compared to the number of new buildings being permitted or built (Fig. 8). Sassi (2006) considers the following advantages for using brownfield sites: it reduces pressure on undeveloped land including greenfield sites; it raises densities, making better use of infrastructure and improving the viability of public transport; it raises social and economic regeneration; it enhances the aesthetic appearance of towns. It should be noted that this predicted expansion or growth should not be made in a linear form, along the existing roads, as done so far, but rather in a concentric way in relation to the city centre. This way urban sprawling can be avoided and meanwhile improved settlement rules must be developed in order that buildings can have the best possible orientation, according to the solar path, thus reducing energy needs for the operation phase of buildings.

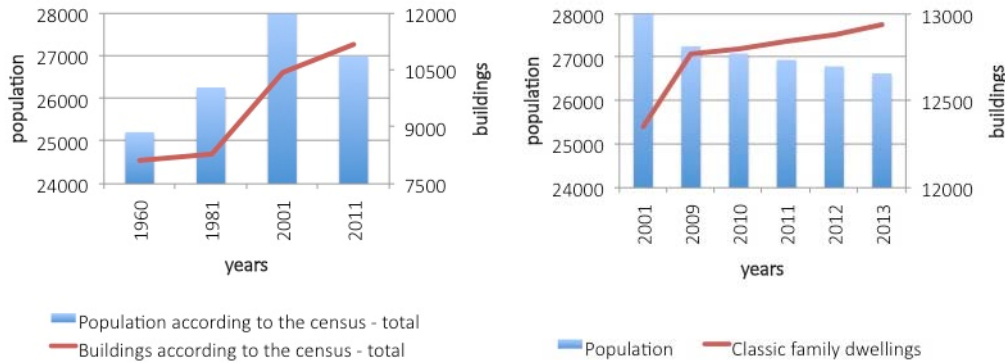


Figure 7. Existing population and existing buildings (source: INE, n.d., cited in Pordata, 2015).

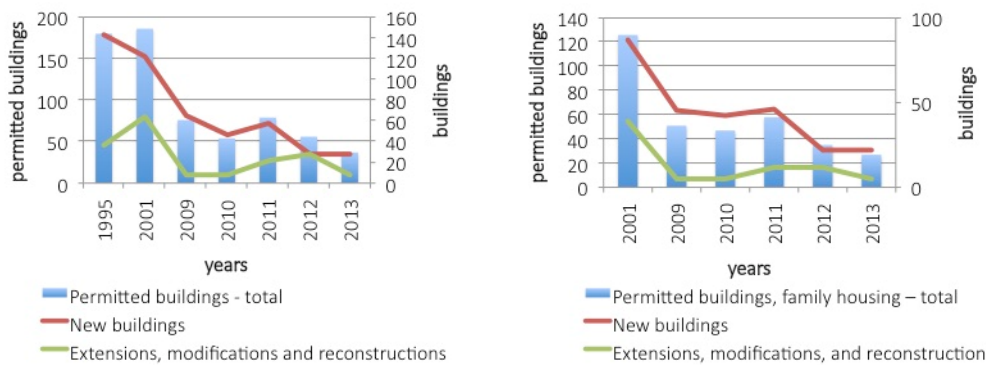


Figure 8. Permitted and concluded buildings (source:INE, n.d., cited in Pordata, 2015).

Another important aspect is the enhancement or creation of new green and social areas. Together with a more compact urban shape, where distances can be shortened, it will not only enhance the potential of the city to be used by pedestrians and cyclists but it will encourage the population itself to do so, thus reducing the need to use energy for transportation. Besides that, urban green areas are in general a crucial provider for urban ecosystem services (Bolund et al, 1999) and positively influence the perceived health of urban dwellers (Maas et al, 2006). In the case of Estarreja larger green and recreational or social areas should be considered, in contrast with the “green corridors” sprawling along the roads, which exist namely in the economic industrial area of the city.

## 6 CONCLUSIONS

The settlements that constitute the municipality of Estarreja have been typically located over or very close to the best agricultural lands, i.e., capable for intensive or moderately intensive agricultural use. If this was not a concern in the past, as the population was rather small and based on agricultural communities, today, and due to the fact that urban communities are growing faster, land use according to its land capability classification should be taken in consideration. In the case of the city of Estarreja, urban growth has been taken place towards a portion of land with lower agricultural potential, when compared to its original location. Nevertheless and despite a shrinking population, a vast portion of the territory as been consumed for urban purposes due to its linear form of expansion. Due to this fact it is necessary to define a limit to the urban area of the city, and urban growth should be based: i) on the use of brownfield sites; ii) and in the rehabilitation and reconstruction of existing abandoned buildings. This way it is possible to save the land for other functions than urban purposes, and to increase the density of population which would decrease the need to build more complex infrastructures and transportation systems. The rehabilitation of existing abandoned buildings will save not only the portions of new land to be used, but at the same time will allow to save the use of new materials and all related life-cycle impacts. The creation of new green and social



areas is also of great importance, as these will prevent waterproofing (avoiding rainwater flooding) and improve the quality of life of the inhabitants. Finally all new constructions should be based on sustainable principles, and its configuration should have the best orientation according to the solar path, thus reducing energy needs. New buildings should also be raised above 2 floors, allowing the densification of the urban areas, and include commercial or service areas, preventing the urban zoning and therefore promoting mixed-use areas.

## ACKNOWLEDGMENTS

The authors would like to thank to OHMI Observatory-Estarreja and Centre National de la Recherche Scientifique (France) for supporting this study.

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