

# Linking agricultural policies with decision making: A spatial approach

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### Abstract

Land-use change has been an increasing concern in most of Europe. While stakeholder's strategies of coping with land-use change have been constrained mainly due to socio-economic pressures, the natural landscape and fragile ecosystems are often harmed due to infrastructure and urbanization development. However, over the last 30 years, public regulations have become more explicit regarding environmental impacts at the regional level. The spatial assessment of ongoing rural and urban policies has led in the case of Portugal to concerns about the consequences of sustainable development in the context of existing legislation. A good example of this is the agricultural land loss that has occurred in Portugal over the last 30 years, in large part resulting from socio-economic pressures with which policy makers have not been able to handle.

The Reserva Agrícola Nacional (RAN) - translated as the National Agricultural Reserve - is an instrument for planning purposes that aims to identify and protect areas suitable for agricultural activities due to their favorable morphological, climatic and social characteristics. The RAN has changed its legal status more than four times in the last 20 years. These changes have mainly been influenced by the policies of regional development for the region. However, the ability to defend the interests of agricultural and rural communities in fragile ecosystems has been largely compromised as a result of socio-economic interactions brought about by the pressures of economic growth.

The spatio-temporal analysis of current land loss and geo-statistical investigation are suitable tools to understand the dynamics of change. The spatial properties of data inventories from the RAN and the CORINE Land Cover project enables the assessment of the changes within the policy context of the Algarve. An integrated assessment of agricultural land loss compared with urban growth parameters and population density is developed to generate a rich laboratory of spatio-temporal analysis of the carrying capacity of the regional/rural environment.

By undertaking a spatial analysis of the appropriation of agricultural land for urban use with overlay of population and urban data, a focus on the consequences of certain regulations on the dynamics of land-use change becomes possible. This paper aims: to further expand on the currently existing decrees which provide support to sustainable development in the region; to provide a qualitative assessment of future roles based on ethical values and economic efficiency; and to offer a feasible framework for policy makers regarding the trends of urban/agricultural dichotomy.

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## **1. Introduction**

Environmental regulation is one of the most fundamental aspects for competitiveness, making it possible: reduce cost for industry and business; generate new markets for environmental goods and services; create jobs; and protect and sustain natural resources to avoid scarcity (Network of Heads of European Environment Protection Agencies, 2005). That said, environmental law which encompasses the Environmental law system may be defined as “an organized way of using all of the laws in our legal system to minimize, prevent, punish, or remedy the consequences of actions which damage or threaten the environment, public health, and safety. (p. 4)” (Steinway, 2007). However, from a strictly anthropocentric perspective, the very core of legislation of environmental issues is overshadowed by the interests of economic growth. The importance of seeing sustainable development as an interconnected reality, where there should be a fair distribution of resources and in which irreversible options must be handled with care (Gladwin et al., 1995) is often forgotten. Thus, environmental regulation is often infringed as a result of economic factors, making efficient regulation an area of dispute between the paradigm of growth and sustainability. This has especially been witnessed in recent decades, where environmental deterioration and increasing economic growth have brought scarcity to certain ecological sectors, such as agriculture and have led to increasing asymmetries.

Attempting to “minimize the consequences on environment” (Steinway, 2007) becomes a very difficult task, calling for regional decrees which legislate and articulate the policies

of sustainable development and environmental change, notwithstanding the paradigm of socio-economic growth. These decrees are, however, often restructured and reorganized to fit the current aspects of environmental degradation, and, as a consequence, they lack a stable and continuous monitoring of sustainability. Environmental degradation caused by human pressure has been observed in different regions of the world. In Europe, where, in general, strong legislation and a good legal system prevails, urban sprawl has been an inevitable. As a result of population increase and socio-economic growth, there has been significant land abandonment, especially in regions with a higher demand for tertiary sector activities. Environmental regulation, however, has not been able to solve this problem, and, taking as an example the Algarve in Portugal, such pressures have directly been responsible for the destruction of fragile ecosystems, loss of agricultural land, and coastal vulnerability. Coastal regions share a twofold problem for policy making: as a socio-economic system, they are located in highly productive regions which are far too complex to allow a linear analysis for policy making (EEA, 2006). On the other hand, the productive cycle of such areas relies heavily on ecosystems functionality which may jeopardize by excessive exploitation of goods and services. From a historical perspective, coastal areas have been the cradle for panoply of resources such as agriculture, leading to settlement patterns which have encouraged regional prosperity. Their unique landscape combines often moderate temperatures with a historico-cultural character which has also led to the development of tourist industries in such areas (Vaz and Nijkamp, 2009). However, excessive growth leads to the deterioration of coastal areas, compromising the resilience of such regions. In the long run, the ecosystem services of littoral regions must be carefully planned so as not to harm the fragile ecological habitats in such areas

(Costanza et al., 1997). The issue becomes one of the resilience of the environmental carrying capacity to support the demand for economic growth. While, for example, tourism may be a beneficial activity to some extent (Lacitignola et al., 2007), bringing jobs to certain coastal areas, the counterpart is rapid land deterioration as a result of seasonal population pressure (Kruger, 2005). The synergetic relation between economic growth and sustainable development is a very complex one, as the effects of socio-economic growth influence the system (or region) in a non-linear way. The dynamics of non-linear complex systems are very difficult to handle, making it necessary for legislation to be multidimensional. However, such environmental legislation has less influence on decision making, while narrowly focused environmental laws have a greater impact (Ruhl, 1999), as their area of application is more precise. Spatial analysis has been largely motivated by different scientific disciplines, such as geography, statistics, economics and mathematics. The analysis of complex systems (although a consensus is still lacking regarding their definition), has enabled to create structural analysis to be made of the combined factors of economic, social, and natural drivers (see Newman, 2005). One of the main advantages of complex systems analysis resides in the possibility of to have an integrated approach to understanding the global consequences of interactions (Taylor, 2005). The availability of spatial information and higher spatial resolution georeferenced economic, social, and environmental strata allows a much more coherent approach to integrated analysis: social, economic, and environmental phenomena happen in a specific space and time (Ryan, 2011). By combining different factors from heterogeneous variables that exist within a territorial unit over time, it becomes possible to find a coherent explanation of the key drivers for environmental

change through spatial metrics, leading to a better approximation of sustainable development (Uemaa et al., 2012). The cross-linkage of policy decisions implies a direct impact on land use and on territorial management (Morari et al., 2004). Spatial information and complex systems may, if combined correctly, create acceptable approaches to land-use change, and provide support in identifying the key drivers for certain land-use changes. This information permits a much more accurate approach to decision making and for understanding the relevant constraints that affect sustainable development (Nijkamp and Scholten, 1993).

### **3. The Study Area**

The Algarve is the southern-most region of Portugal and has a unique ecological landscape, which forms a part of the continental network of conservation habitats, defined under the European Union Directives: 79/409/CEE and 92/43/CEE.

In terms of its geomorphology of the Algarve may be divided into three different areas: the *Interior*, the *Barrocal*, and the *Litoral*, but there is a significant asymmetry between the *Interior* (located at the north of the region) and the *Litoral* (the coastal areas of the Algarve). Figure 1 represents the geographical region of the Algarve and within it the land which is part of NATURA 2000 network. However, the increasing asymmetries between population escalations in the south of the Algarve compared with decline in the north, are jeopardizing the important ecosystems (Vaz et al., 2012) and putting at risk the development agenda of rural areas.

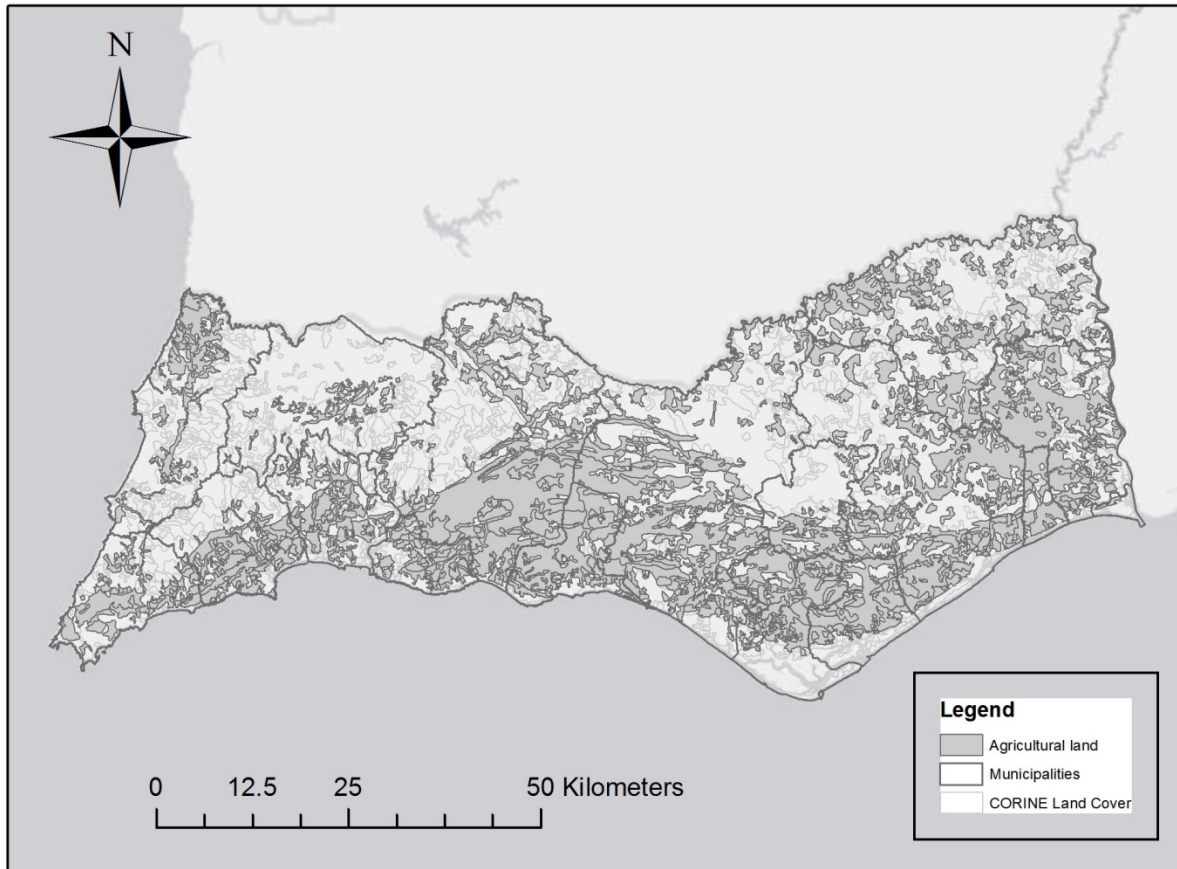


Figure 1 – Location of protected areas within the municipalities of the Algarve

While agricultural activity has been high in the *Barrocal*, which mostly in carob production, and in the *Interior*, where there is sheep herding and other agro-pastoral activities (Assunção, 1989), the *Litoral* has largely lost its agricultural sector to the exploration of tourism activities. Since the 1960s, the increase of tourism brought about by low-cost flights throughout Europe has been seen as an opportunity for economic growth and prosperity for the region. The creation of amenities and infrastructures to support a massive tourism industry has changed the activities of the primary sector to those of the tertiary sector, focusing predominantly on the service sector related to tourism. The development of the tourist industry has provided better job opportunities,

attracting a massive concentration of population in the Algarve, contributing directly to coastal population increase. Figure 2 shows the trend of population growth tendency since mid XVII century.

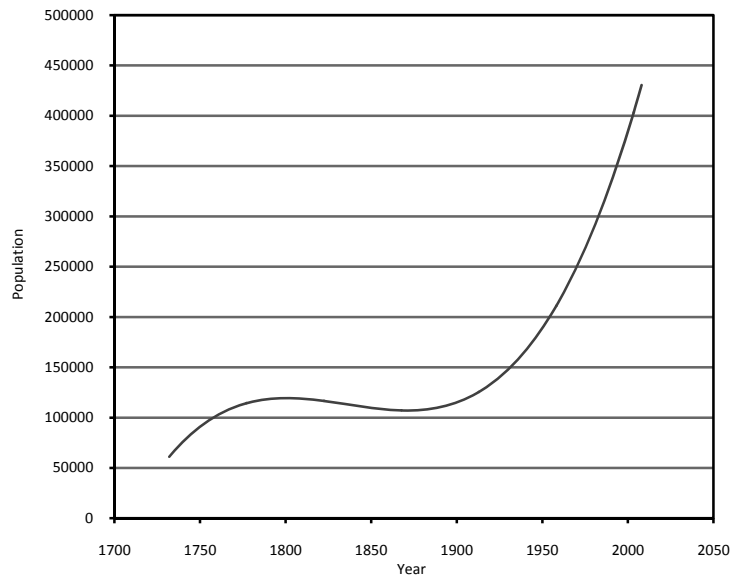


Figure 2 - Population growth in the Algarve since the XVII century

The exponential growth that the Algarve has experienced has particularly increased during the 1980s, and is a reflection of the mass tourism industry. While population in the Algarve in 1973 was of 63,682 inhabitants, by 1992, the growth rate was 167.62 per cent bringing the total population to 411,468 in 2004. The increase in population during the 18th century was a direct result of the efficiency of the local fishing industry, which provided jobs and economic prosperity during the 18th and 19th centuries. Another marked rise in the growth rate is registered during the 1990s, directly related to a new type of economic growth resulting from the development of the low-cost carriers for tourism purposes. In 2008, the Algarve region had a density of approximately 80 inhabitants per km<sup>2</sup>. The asymmetry between the coastal area and the northern area of the



Algarve create a great variation in densities which is exacerbated during the summer months when its population triples clustering in the areas of tertiary sectors. Figure 3 shows the population density per parish, clearly reflecting the pattern of clusters along the coastal areas and lower densities in the interior.

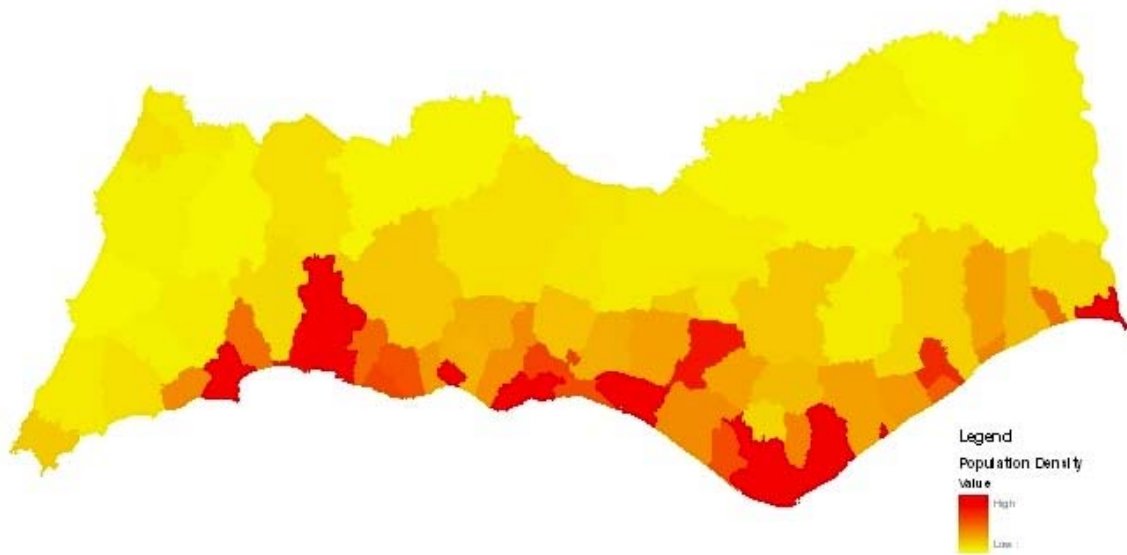


Figure 3 - Population density per Parish

The areas with the highest population density can be seen in the surroundings of Faro, the district capital of the Algarve, and in the areas of Albufeira, Portimão and Vila Real de Santo António.

#### **4. Data and Methodology**

This study is centred on the changes in the extent of Portuguese agricultural land since the end of the 1990s until the present. The depletion of the Algarve's rural areas in recent decades is accelerating and may lead to scarcity in the region. Loss of natural habitats and

biodiversity are an increasing concern for regional policy makers, and are widely recognized in the Municipal Plans of the Algarve (Petrov et al., 2009).

Methodologically, the main objective of this study is to create comparable spatial data sets derived from land-use maps regarding urban land use and cross-link these with the loss of agricultural land by appropriation for urban use in the municipalities of the Algarve. Thus, this study proposes a land-use accounting methodology which involves studying population density dynamics and urban growth variations for similar time frames. This accounting methodology allows the main driver for agricultural land loss to be identified i.e. it considers whether urban growth may be considered as a significant driver for loss of rural areas, or, on the other hand, systemic population decrease in rural areas might be a key driver of agricultural land appropriation resulting in rural land abandonment, a common concern for the European Union (Weissteiner et al., 2011). A multi-temporal analysis for the decades of the 1990s and 2000, allows changes in the extent of both urban and agricultural areas to be tracked. These dynamics are registered as urban variations and agricultural land appropriation variations and assessed together with the population density profile per municipality. The impact of this analysis (see Figure 4) leads to a firm characterization of the responsible driver, as well as, a hypothetical evaluation of future trends regarding agricultural land use and population density for the region of the Algarve. This qualitative analysis, combined with the quantitative support from spatial data, enables a better understanding of the dynamics of sustainable development, considering that urban growth is an inevitable reality, but that the need for sustainable cities must also be taken into account.

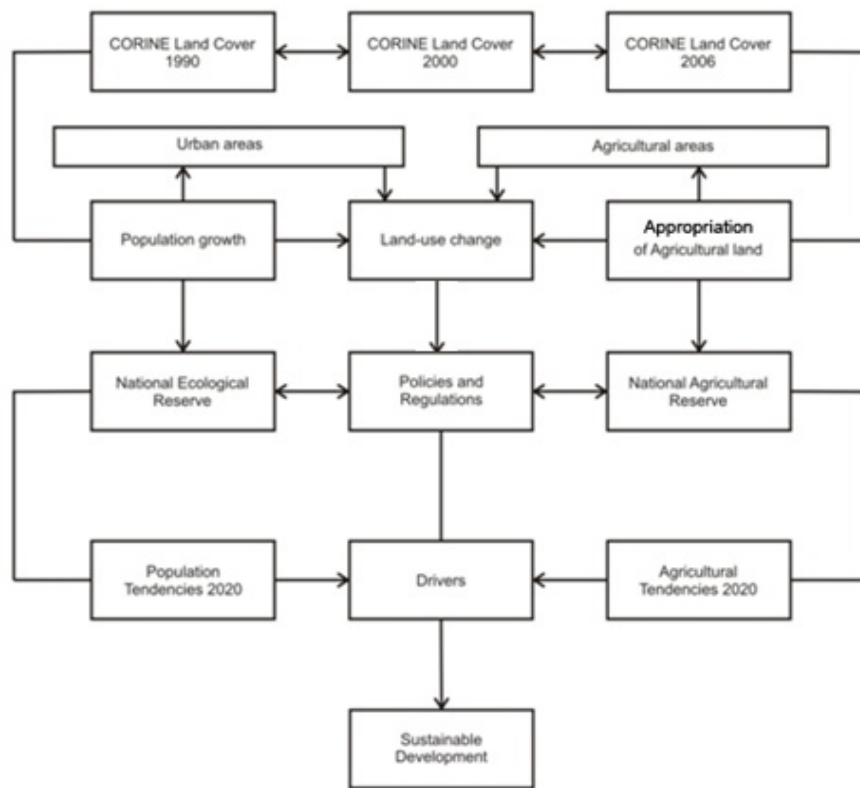


Figure 4 - Flow diagram of methodology

The comparison of the realities of both loss of agricultural land derived from land loss inventories and urban growth will allow us to have a comparative analysis using spatial information. Figure 4 shows the workflow involved in the comparison of the CORINE Land Cover period for 1990, 2000 and 2006 with the population growth surveys conducted from 1991 to 2008. Given the change analysis of the CLC periods, urban areas and agricultural areas are mutually assessed to examine land-use change. The diagnosis of population growth and appropriation of agricultural land are reported within the Directives of the framework of regulation between 1989 and 2008. The strategies for the National and Ecological Reserve and for the National Agricultural Reserve are based on existing policies, designed to sustain the available carrying capacity in order to take into

account the pressure of population tendencies for the period up to 2020 and agricultural trends for the same period. Population increase and urban growth were compared at the three time stamps available for CORINE Land Cover. Population increase showed a predominant tendency to locate at the coastal fringe, while urban sprawl occurred in the same areas where population change was evident. This comparison was made by normalizing population and urban density from 0-1, where the normalisation of urban density was computed as a result of considering 1 the total urbanisation and 0 to regions with no urbanisation. The multiple time series of population, urban quantification, agricultural quantification, and appropriation of agricultural land, as well as difference in the distribution of density allow a comparison of land loss and socio-economic driving forces. The result of this quantification will mitigate the impacts of urban pressure on the coastal areas of the Algarve, as well as recognize the on-going legal importance of quantitative spatial analysis within the notions of land appropriation for urbanization.

The CORINE Land Cover project (CLC) may be considered as a first attempt to derive spatial information about land use in the European context. The CLC started on 27 June 1985, as a programme that would address the following issues: State of individual environments; Geographical distribution and state of natural areas; Geographical distribution and abundance of wild fauna and flora; Quality and abundance of water resources; Land cover structure and the state of the soil; Quantities of toxic substances discharged into environments; and List of Natural Hazards (EEA, 1995). In this sense, the CLC can be seen as an experimental project for gathering, coordinating and ensuring the consistency of information on the state of the environment and natural resources in the Community (85/338/EEC, Council Decision 27/6/1985 ).

The Reserva Agrícola Nacional is a Portuguese tool for land management, which covers those areas which due to their favourable morphological, climatic and social conditions are considered to have the most potential for the development of agricultural activities. Essentially, the areas included within the RAN are more fertile, and, thus, would be a serious loss if appropriated for. Nevertheless, local patterns of agricultural activity, typical of the rural areas of the Algarve, have lost some of their traditional positive externalities, leading to an increase in negative externalities generated by non-systemic production sectors. This led in 1976 to the “Land-use Law” (Decreto Lei n. 794/76, 5th November), which brought policies for urban control, and the planning of agricultural activity. However, urban and population pressure, as well as the existing concentration on the secondary and the tertiary sector have led to further agricultural abandonment, and inevitable urban growth in Portugal. A special framework of legislation was conceived in 1982, which expressed the concerns about agricultural land loss, and thus the RAN (Decreto Lei n. 451/82, 16th November) was created, with the main objective of recovering lost agricultural and abandoned land and protecting vulnerable agricultural areas. The RAN is divided in two distinct classes (A and B), based on physical and geographical characteristics (Decreto Lei n. 196/89, 14th June). RAN land is systematically decreasing, while urban areas are registering a steady increase (Figure 5).

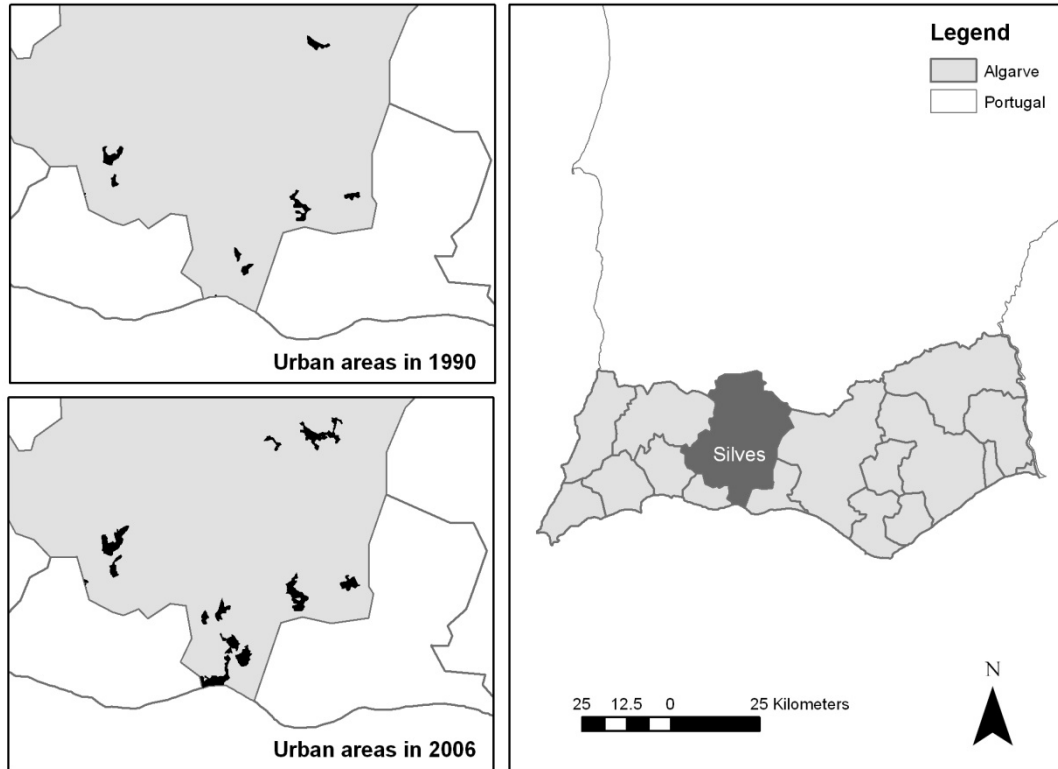


Figure 5 – Urban growth change in Silves

A closer analysis of land appropriation over the last decades shows a fluctuating pattern especially felt since 1996 (Figure 6). Strongly linked to existing land-use policies, the appropriation patterns show an increase since 1994, and in 2005 register the most significant appropriation of RAN land, with a total of 3,722,864 m<sup>2</sup> lost.

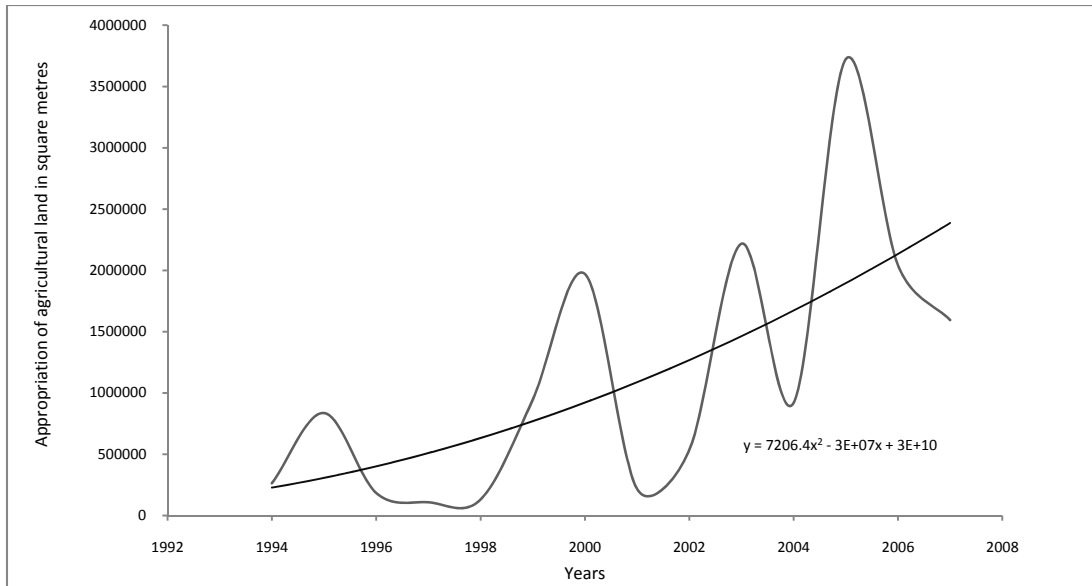


Figure 6 - Evolution of agricultural land appropriation

This pattern is of increasing concern, given the fluctuating nature of agricultural land appropriation and the increasing trend-line of loss of agricultural land. While the peak is, for now, registered in 2005, it seems to be expected that, with the current trend registered over the last decade and a half, that one might expect a further increase in 2010 to a peak comparable in 2003 for land appropriation in 2010. A closer analysis of urban growth tendencies for the Algarve region, as analysed by Vaz and others (2011), shows the overwhelming tendency of agricultural land loss due to urban pressure.

Analysis of urban growth patterns between the 1990s and 2006 demonstrates a continuous growth along all of the Municipalities (Table 2).

Table 2 - Ratio of urban land variation from CLC 90 to CLC 06 (in pixels)

Municipality	Urban land 90	Urban land 2006	Variation	Ratio
Castro Marim	3463	14145	10682	0.76
Alcoutim	506	2032	1526	0.75
Monchique	1304	5068	3764	0.74
Silves	10445	25517	15072	0.59
Vila do Bispo	6128	14510	8382	0.58
Tavira	7775	17942	10167	0.57
São Brás de Alportel	1836	4149	2313	0.56
Vila Real de Santo António	7816	17374	9558	0.55
Loulé	53601	116356	62755	0.54
Lagos	20980	44301	23321	0.53
Albufeira	30404	64128	33724	0.53
Lagoa	22264	45685	23421	0.51
Olhão	11407	21617	10210	0.47
Portimão	31276	53941	22665	0.42
Faro	21748	30750	9002	0.29
Aljezur	10990	14446	3456	0.24

Although all municipalities registered significant increase over the 15 years of study, a clear increase in urban sprawl has been verified in Castro Marim, Alcoutim and Silves. Curiously, these areas have had a long tradition in the agricultural sector in the Algarve, and have been subjected quite rapidly to urban growth. A further analysis of population density patterns in the Algarve, which also reflects this increase, may be a direct result of competitive prices for construction, as well as of existing road-networks that allow communication to important cities such as Faro, Portimão and Albufeira.

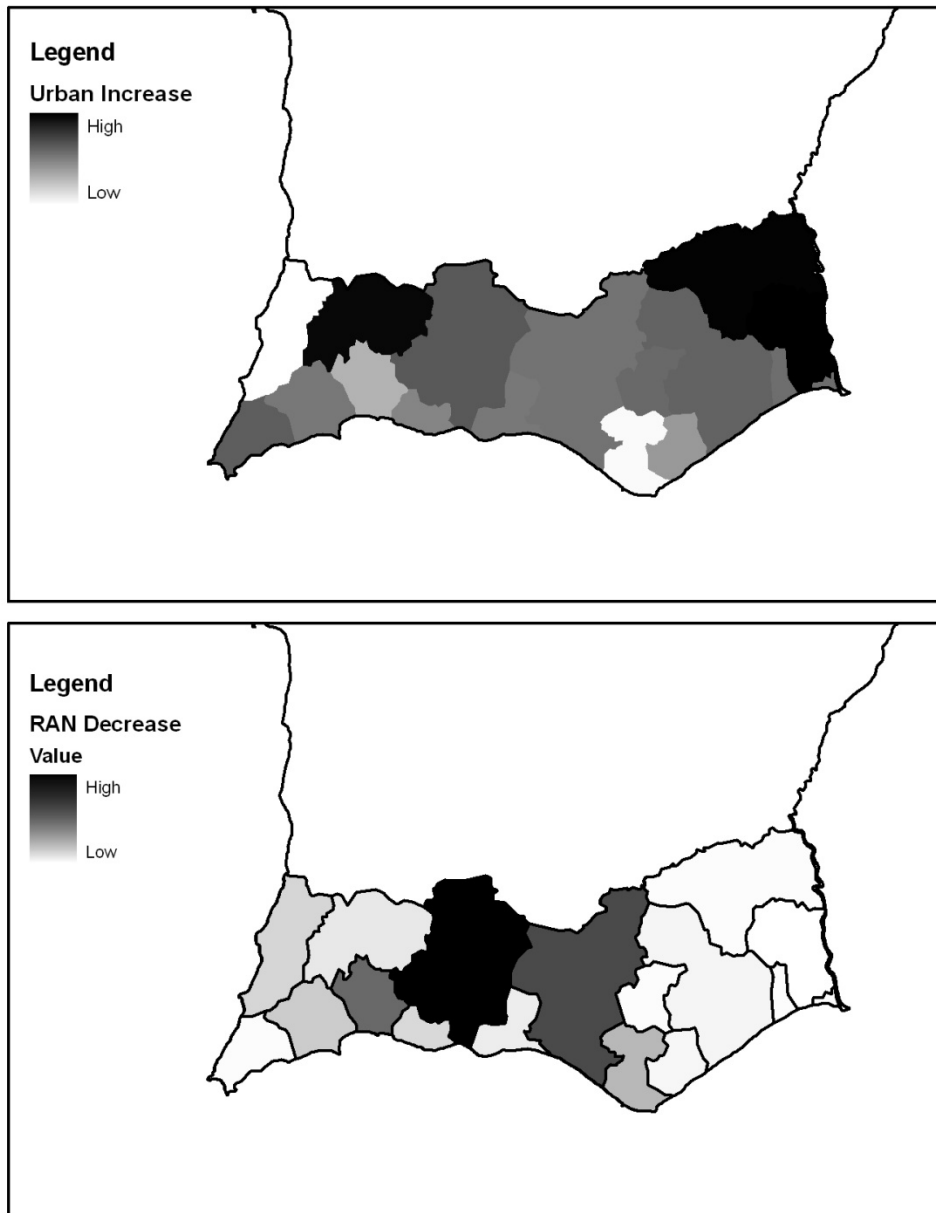


## 5. Conclusions

### *5.1. Urban growth and Agricultural land loss*

A comparative analysis of existing land-use patterns regarding the appropriation, that is, the re-designation of agricultural land for urban use, allowed us to compare the results of urban variation per municipality with variation of loss of the RAN. The Algarve has witnessed severe loss of agricultural areas and significant decrease of the RAN. These changes, looking at the recent development of the European recession suggest also that most of the agricultural areas will continue to face increasing abandonment in detriment of leapfrogging of peri-urban infrastructure. The combination of assessing urban land and changes in the RAN, have allowed to understand the impacts of both urban concentration in littoral areas, but also understand at spatial level the dynamics of land use change in the Algarve. The municipal information for the Algarve also fosters the possibility to understand at local level impacts of these changes, such as the case of Silves, where agricultural production has been traditionally high, and current urban growth is following the tendencies of construction in peri-urban areas. Data sets of the RAN were summed to the same time frames as CLC data, and information were cross-linked. The result showed that Alcoutim, Monchique and Silves, with the most urban growth, also showed explicit loss of agricultural land by infringing the Agricultural regulation of the RAN in the case of Silves. While at the local level this information is not evident, a regional quantification of variations of the RAN and urban areas provide crucial information of land-change patterns for the Algarve. The combination of land use accounting methods, taking

advantage from combining different spatial inventories, allows for a better decision making in areas of rapid urban and agricultural land use transitions due to internal and external environmental, social and economic pressures. Geographic Information Systems therefore, may be understood as tools that allow hosting better local management, as well as bring more accurate information on current challenges facing the landscape as well as the rural environment of Europe's regions.



**Figure 7** – Comparison of RAN decrease and urban increase in the Algarve

While this acknowledgement is quite obvious, the Algarve shows an increasing tendency of land appropriation, with a rising propensity for urban growth along the appropriated lands. This pattern seems to be combined with a fluctuating tendency of policies in the areas which have allowed the appropriation of agricultural land during certain years (2000, 2003 and 2005), where these appropriations are mainly linked to important regional activities such as the Euro 2004 football championship.

The economic prosperity brought by the tourist industry, has stimulated the strategy of the creation of infrastructures within the Algarve. Within the concept that currently promotes the Algarve as a sun and beach district – the “Allgarve” – appropriation of agricultural land has led to unavoidable agricultural land loss, especially in peri-urban fringes. The environmental consequences of this growth are evident: traditional agricultural land has greatly decreased, while new infrastructures have increased around certain central areas along the coastal regions.

## ***5.2. The Reserva Agrícola Nacional in the future***

On the 29 January 2009 a new legislation came to force Reserva Agrícola Nacional (RAN) under the law 196/1989 of the 4th of June, the objective of this law is, is to reinforce the legal nature and the importance of the public administration of the RAN. According to the United Nations definition and nomenclature of territories, methodologically, this classification envisages the better protection of natural resources throughout the country.

For the first time in the regulation history of the RAN, the use of digital information derived from geo-referenced data sets will have an important role in the analysis and synthesis of crucial information for better management. While in recent there have been an unbalanced management of agricultural land as an inevitable result of the economic growth of urban areas, in the future the better integration of information could lead to improved decision making. The Comissão Regional da Reserva Agrícola might have an important role in reshaping the balance of sustainable development for the Algarve.

It is likely that spatial information will have an important role in creating synergy within this Commission, allowing more interactive and more soundly-based decision making.

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