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Linking Agricultural Policies with Decision-Making: A Spatial Approach

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Abstract *The loss of agricultural land and its implications have been of great concern in the last decade. By undertaking a spatial analysis of the appropriation of agricultural land for urban use with an overlay of population and urban data, a focus on the consequences of certain regulations on the dynamics of land-use change is explored. This is achieved by integration of data inventories of agricultural land use for Portugal, and linking this information with CORINE Land Cover data as to assess change in the Algarve. An integrated assessment of agricultural land loss follows, undermined by the consequences of urban sprawl. In this sense, this paper expands on the currently existing decrees which provide support to sustainable development in the region while providing a qualitative assessment of future roles based on ethical values and economic efficiency and offering a feasible framework for policy-makers regarding the trends of urban/agricultural dichotomy in a planning and decision-making context.*

1. Introduction

Environmental regulation is one of the most fundamental aspects of 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" (Steinway, 2007, p. 4). 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

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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 inevitable (Vaz *et al*., 2012a). 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 (Vaz, 2014). Coastal regions share a two-fold 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 be jeopardized by excessive exploitation of goods and services. From a historical perspective, coastal areas have been the cradle for a 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 & 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 the creation of 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 having an integrated approach to understanding the global consequences of interactions (Taylor, 2005). The availability of spatial information and higher spatial resolution geo-referenced 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 (Uuemaa *et al*., 2013). 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 understanding the relevant constraints that affect sustainable development (Nijkamp & Scholten, 1993).

2. 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, 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*., 2012b) and putting at risk the development agenda of rural areas.

While agricultural activity has been high in the "Barrocal", which mostly does carob production, and in the "Interior", where sheep herding and other agro-pastoral activities are seen (Assunção, 1989), the "Litoral" has largely lost its agricultural sector to the exploration of tourism activities (Vaz & Campos, 2013). 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 since the mid-seventeenth 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 the population in the Algarve in 1973 was 63,682 inhabitants, by 1992, the growth rate was 167.62% bringing the total population to 411,468 in 2004. The increase in population during the eighteenth century was a direct result of the efficiency of the local fishing industry, which provided jobs and economic prosperity during the eighteenth and nineteenth

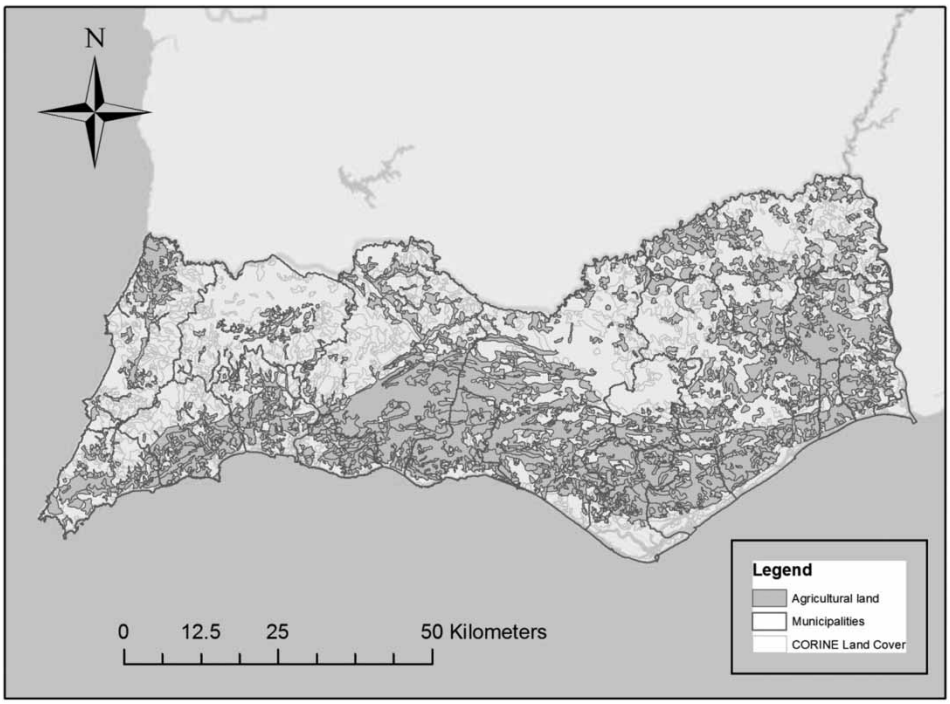

Figure 1. Location of protected areas within the municipalities of the Algarve.

centuries. Another marked rise in the growth rate was 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 square kilometre. The asymmetry between the coastal area and the northern area of the Algarve creates 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.

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.

3. 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 is an increasing concern for regional policy-makers (Vaz & Noronha, 2014), 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

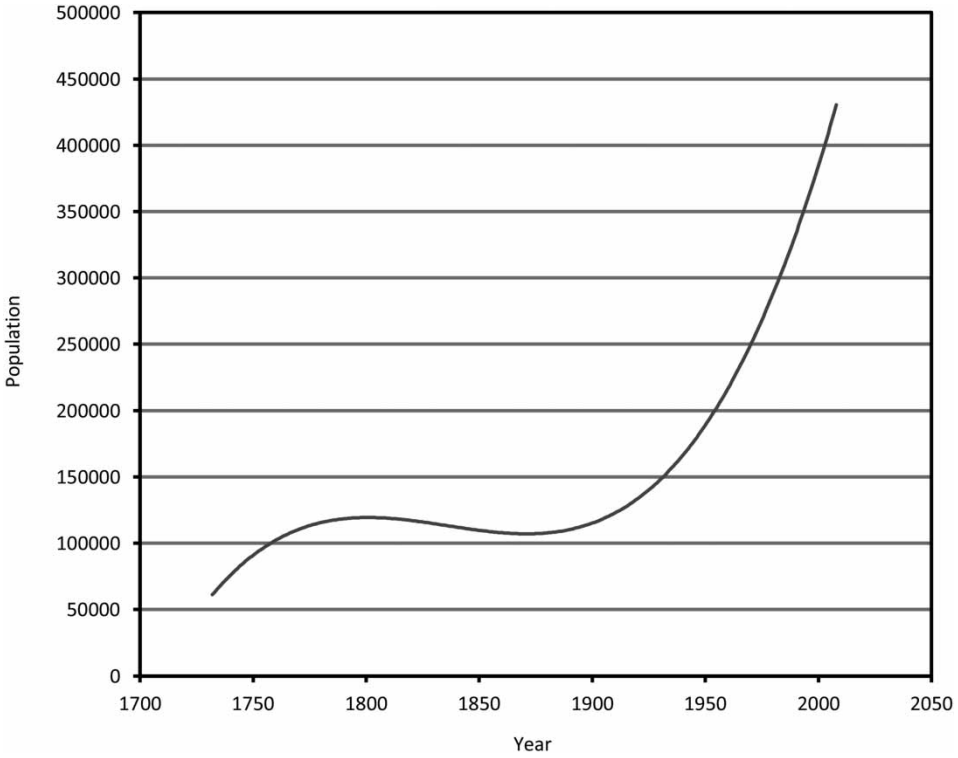

Figure 2. Population growth in the Algarve since the seventeenth century.

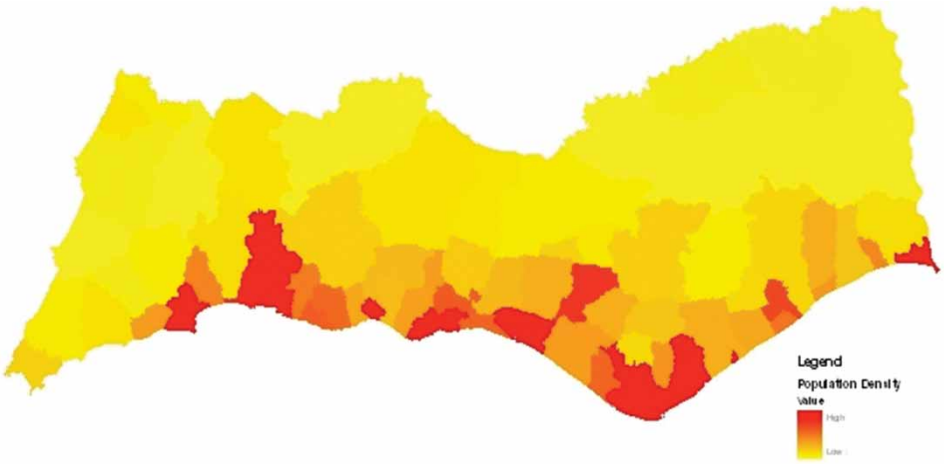

Figure 3. Population density per Parish.

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, that is, it considers whether urban growth may be regarded 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 (Vaz *et al.*, 2014). 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.

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

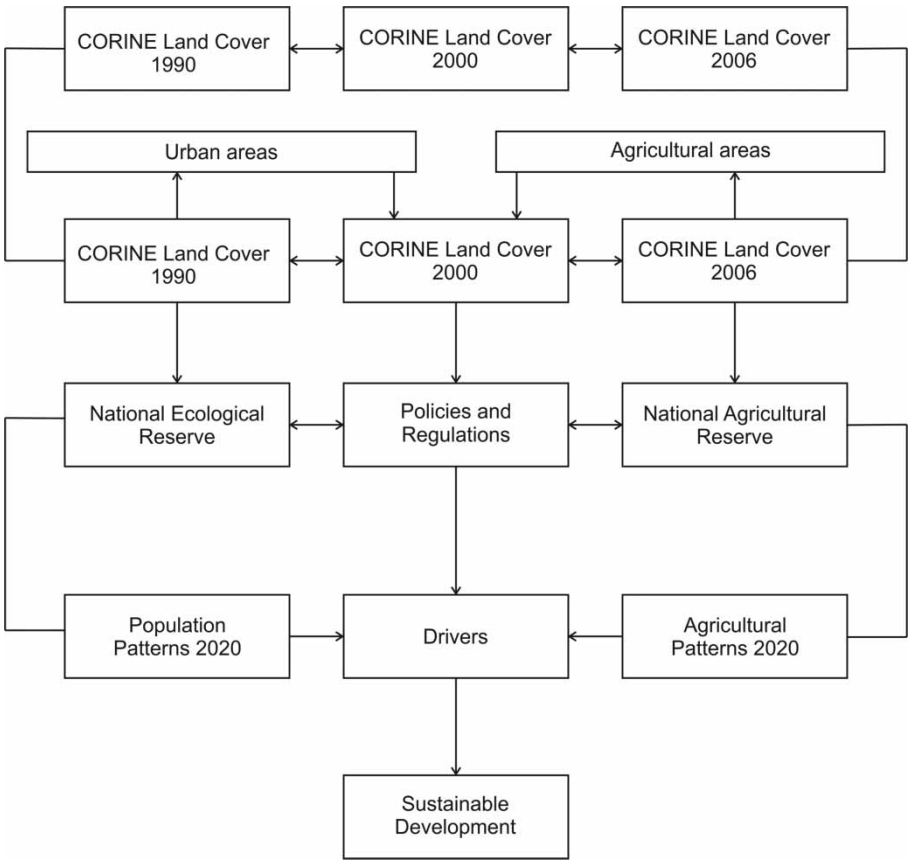

Figure 4. Flow diagram of methodology.

information. Figure 4 shows the workflow involved in the comparison of the CORINE Land Cover (CLC) 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 diagnoses 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 (Vaz & Nijkamp, 2014). This comparison was made by normalizing population and urban density from 0 to 1, where the normalization of urban density was computed as a result of considering 1, the total urbanization, and 0, regions with no urbanization. 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 CLC project may be considered as a first attempt to derive spatial information about land use in the European context (Vaz & Aversa, 2013). The CLC project 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 (RAN) 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. 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, 5 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 concerns about agricultural land loss, and thus the RAN (Decreto Lei n. 451/82, 16 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

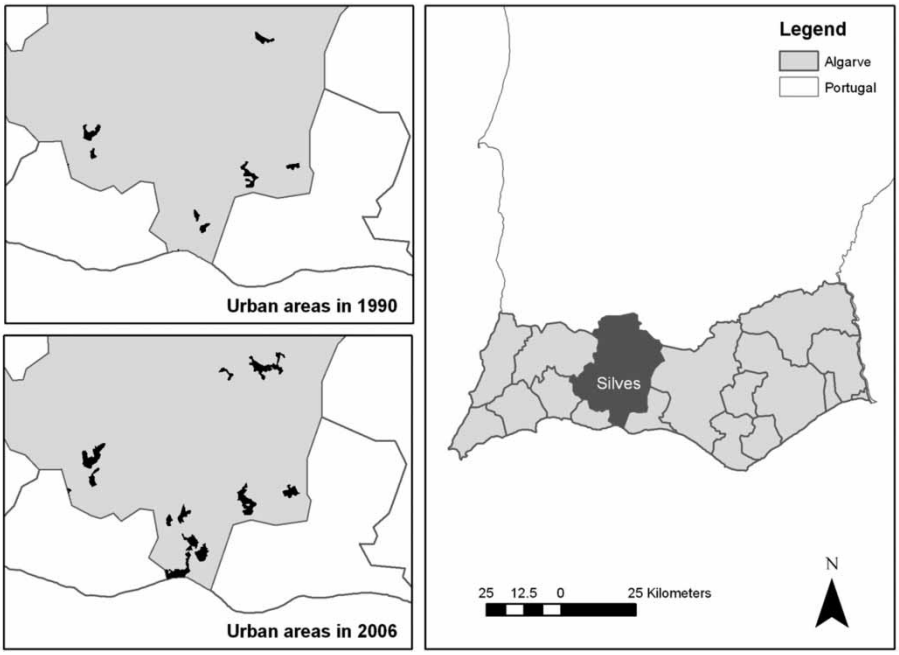

Figure 5. Urban growth change in Silves.

characteristics (Decreto Lei n. 196/89, 14 June). RAN land is systematically decreasing, while urban areas are registering a steady increase (Figure 5).

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

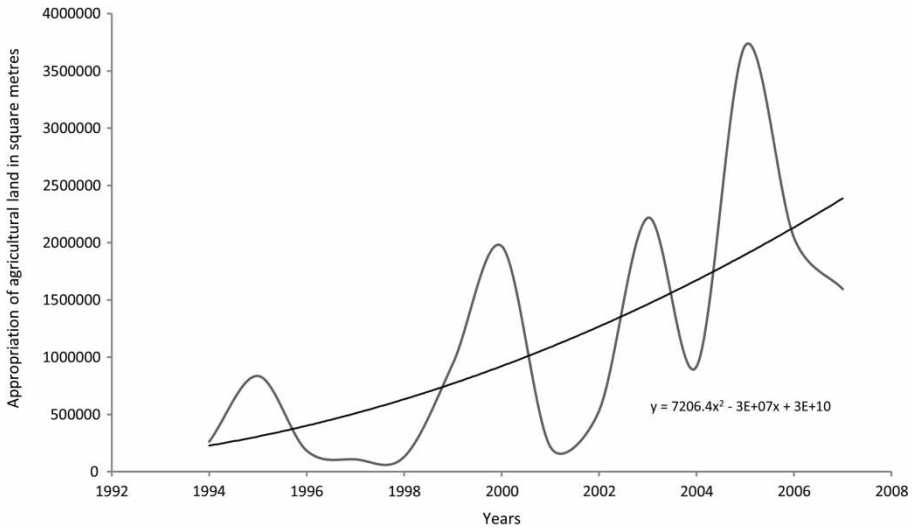

Figure 6. Evolution of agricultural land appropriation.

Table 1. 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	14,145	10,682	0.76
Alcoutim	506	2032	1526	0.75
Monchique	1304	5068	3764	0.74
Silves	10,445	25,517	15,072	0.59
Vila do Bispo	6128	14,510	8382	0.58
Tavira	7775	17,942	10,167	0.57
São Brás de Alportel	1836	4149	2313	0.56
Vila Real de Santo António	7816	17,374	9558	0.55
Loulé	53,601	116,356	62,755	0.54
Lagos	20,980	44,301	23,321	0.53
Albufeira	30,404	64,128	33,724	0.53
Lagoa	22,264	45,685	23,421	0.51
Olhão	11,407	21,617	10,210	0.47
Portimão	31,276	53,941	22,665	0.42
Faro	21,748	30,750	9002	0.29
Aljezur	10,990	14,446	3456	0.24

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^2 lost.

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, 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 *et al.* (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 1).

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.

4. Conclusions

4.1. *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 the leapfrogging of the peri-urban infrastructure. The combination of assessing urban land and changes in the RAN has allowed the understanding of the impacts of urban concentration in Litoral areas, but also understand at the spatial level the dynamics of land-use change in the Algarve. The municipal information for the Algarve also fosters the possibility of understanding at the local level the 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 was 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 provides crucial information of land-change patterns for the Algarve. The combination of land-use accounting methods, taking advantage of combining different spatial inventories, allows for a better decision-making in areas of rapid urban and agricultural land-use transitions due to the internal and external environmental and social and economic pressures. Geographic Information Systems therefore, may be understood as tools that allow hosting better local management, as well as bringing more accurate information on current challenges facing the landscape as well as the rural environment of Europe's regions (Figure 7).

While this acknowledgement is quite obvious, the Algarve shows an increasing tendency towards 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 infrastructure 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 infrastructure has increased around certain central areas along the coastal regions.

4.2. *The RAN in the Future*

On 29 January 2009, a new legislation came to force RAN under the law 196/1989 of the 4th of June; the objective of this law 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

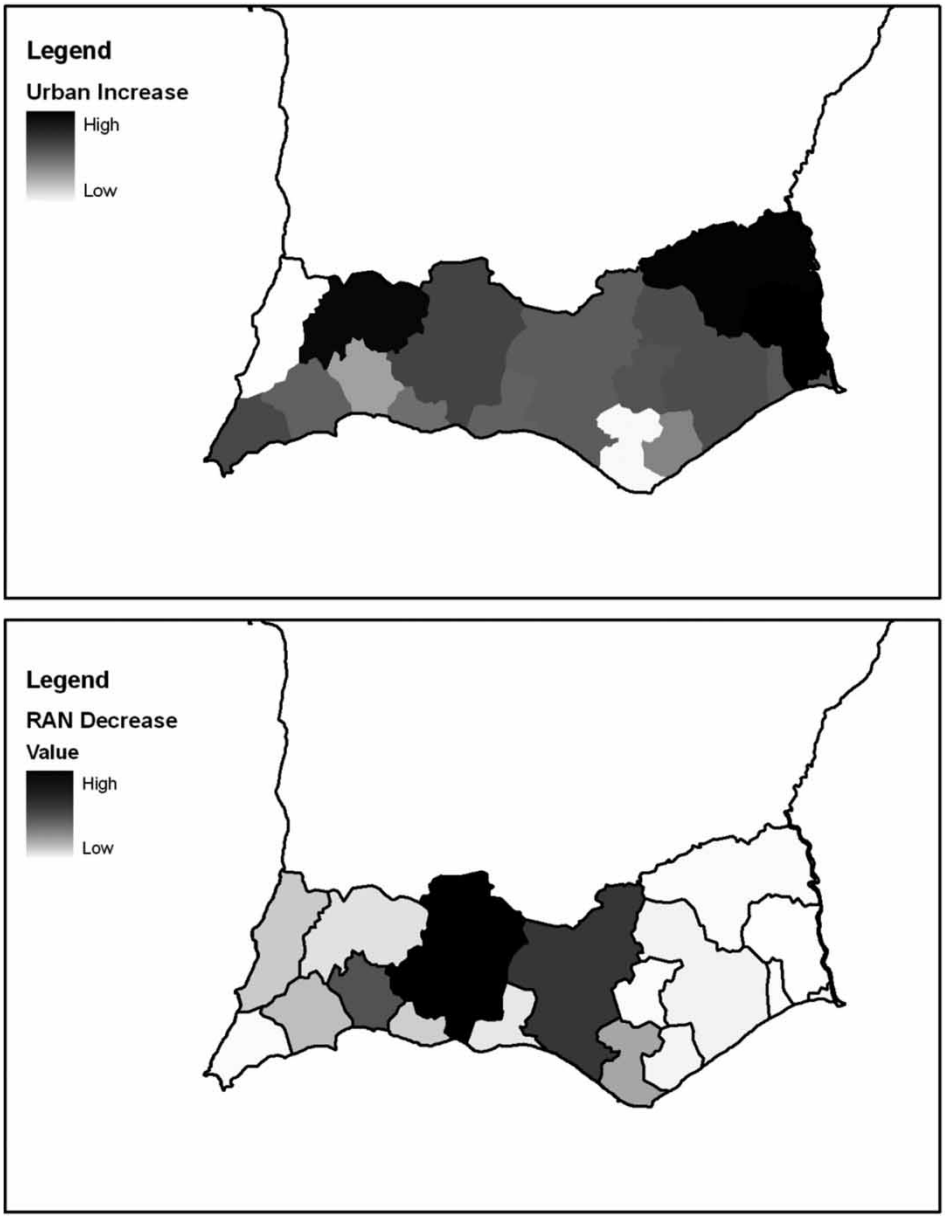

Figure 7. Comparison of RAN decrease and urban increase in the Algarve.

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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