

**Land-use changes in Coastal Alentejo<sup>1</sup>:**  
Methodological Approach to Understand the Interactions Nature / Society in Coastal Areas \*

**Mudanças do Uso do Solo na Área Costeira Alentejana:**  
Metodologia Integrada para o Estudo das Interações Homem / Meio nas Áreas Costeiras \*

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**Keywords:** Coastal areas, land-use, agents of change, integrated methodology, Coastal Alentejo

## ABSTRACT

This paper deals with the identification of the required conditions for a real integration of disciplines, without which an integrated analysis may not be possible. To do so we are searching the information that is necessary to fulfil the objective of an integrated methodology.

Being land use and land use changes one of the main issues integrating the large debate on sustainable development, its analysis demand clearly an integration of spatial / landscape data with the socio-economic data type which has been recently widely recognised. The question is how this integration is possible, and how can it best be achieved. Moreover, the land use changes studies must be a contextualised analysis centred in the individual inside the context where he acts. This departing point assumes that the individual induces the land use changes but he also reflects the changes made by other agents that intervene, directly or indirectly, in the land use. So we must consider and analyse the impact of external driving forces such as the national and international policies and regulations. Thus we are making an effort to make this analysis at a Regional Level, a Local Level and Individual Level.

The coastal areas are special focus given the increasing importance that they had assumed in the global frame of the present economic development. The number and diversity of agents that are searching for space in coastal areas increases the needs for an integrated management in a way to minimise the negative impacts of the increasing number of activities. The nature and distribution of human activities on coastal areas result from the action of a range of driving forces – demographic, institutional, commercial and market, cultural and technological. The impact of these forces explains the land use changes and the way in which the coastal resources are affected.

Toward the identification and understanding the environmental problems of coastal areas it is important, therefore, to analyse the efficacy of the administrative structures at the level of the formulation of the legislative frame and its practice giving possible to understand the articulation, at distinct levels of the institutional dimensions. Moreover the institutional frame, given the integration of Portugal in the European Union since the middle eighties, is in part the reflection of the problems and needs, which are perceived also at the international level. In Portugal the responsibility of management of coastal resources is distributed by several administrative structures that intervene at different spatial levels (national, regional and local levels). This intervention present some contradictions caused by the different objectives of the planning tools, which frame those administrative structures

In what relates to the methodological design, this study is based in an integrated perspective that aims at understand the processes of land use change. The association of different scientific approaches and levels of analysis will accomplish this posture of integration. However, this multi-disciplinary integration can not be faced as a superimposition or assembling of divers empirical approaches. It represents an articulation between the different scientific domains and levels of spatial or time analysis. The time

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analysis it is a significant element of the methodological design. If this studies aim at understand the processes of land use change, it is required to analyse different periods, besides the study of different rhythms or cycles of the phenomena. The accurate study of these different moments must contemplate the changes of the biophysical and social frames. The land use change is, therefore, the reflection of the practices of the different agents conditioned by the changes in the global frame of each period. In order to articulate these spatial and temporal levels of analysis of the georeferenced data it was implemented a GIS. How to articulate information from different sources and natures, different scales into the system of analysis is one of the main challenges of the work carried on.

## RESUMO

Este artigo pretende identificar as condições necessárias para uma integração real das diferentes disciplinas, sem as quais uma análise integrada destes problemas não é possível. Para tal é preciso procurar a informação necessária para atingir os objectivos de uma metodologia integrada.

Constituindo o uso do solo e as mudanças de uso do solo um dos principais temas que integram o debate sobre o desenvolvimento sustentável, o seu estudo exige a integração de análises espaciais e de análises socio-económicas, facto que tem sido, nos últimos anos, largamente reconhecido. A questão que se coloca é a forma como este tipo de integração é possível e pode ser bem sucedida. Além disso, os estudos sobre as mudanças de uso do solo devem ser uma análise contextualizada, centrada no indivíduo inserido no contexto em que actua. Este ponto de partida assume que os indivíduos induzem as mudanças de uso do solo mas também reflectem as mudanças efectuadas por outros agentes, que intervêm, directa ou indirectamente, no uso do solo. Assim, é fundamental analisar o impacto de factores de mudança globais como as políticas, normas e regulamentos de âmbito nacional e internacional. Daí a necessidade de realizar este tipo de estudos em diferentes níveis de análise: nível regional, nível local, nível individual.

As áreas litorais justificam uma atenção especial dada a crescente importância que têm vindo a assumir no actual quadro de desenvolvimento económico à escala global. O número de agentes que solicitam espaço na faixa litoral, bem como a sua diversidade, reforça a necessidade de uma gestão fundamentada em estudos integrados, de modo a poder ser minimizado o impacte resultante do crescente número de actividades praticadas. O tipo e a distribuição das actividades humanas nas áreas costeiras é o resultado da acção de variados factores de mudança - demográficos, institucionais, comerciais e de mercado, culturais e tecnológicos. O impacto destes factores explica em grande parte as mudanças de uso do solo pelas quais os recursos das áreas costeiras são afectados.

Para identificar e compreender os problemas ambientais das áreas costeiras torna-se, deste modo, importante analisar a eficácia das estruturas administrativas ao nível da elaboração do corpo legislativo e da sua aplicação, tornando possível o conhecimento dos diferentes níveis de aplicação das dimensões institucionais. Para além disso o quadro institucional, dada a integração de Portugal na União Europeia, é em larga medida reflexo de problemas e necessidades que se fazem sentir ao nível internacional. Em Portugal, a responsabilidade da gestão dos recursos costeiros encontra-se repartida por várias estruturas administrativas, que intervêm a diferentes níveis espaciais (nacional, regional e local). Esta intervenção reveste-se de alguma conflitualidade provocada pelos diferentes objectivos dos instrumentos de planeamento que enquadram aquelas estruturas.

Ao nível do desenho metodológico, o estudo assenta numa perspectiva de integração que visa compreender os processos de mudança de uso do solo. Esta perspectiva de integração é realizada associando diferentes abordagens científicas e níveis de análise. No entanto, a integração multi-disciplinar não pode ser encarada como sinónimo de sobreposição ou de junção de diferentes abordagens empíricas. Ela pretende atingir uma lógica de articulação entre os diferentes domínios científicos e os diferentes níveis de análise espacial e temporal. A análise temporal é um dos elementos fundamentais do desenho metodológico deste estudo. Assim, se o objectivo deste tipo de análise consiste na compreensão dos processos de mudança de uso do solo é necessário atender, para além dos diferentes ritmos e ciclos dos diversos fenómenos, a vários momentos de análise. A correcta análise destes diferentes momentos deve considerar o diferente quadro biofísico e social que preside a cada momento. A evolução do uso do solo é, deste modo, o reflexo dos processos de intervenção de diversos agentes, condicionados pela evolução do enquadramento global existente em cada época. Para conjugar estes níveis espaciais e temporais da informação geograficamente referenciada constituiu-se um SIG. A forma de articulação de todo este conjunto de dados com diferentes origens é um dos grandes desafios de todo este trabalho.

## LAND-USE CHANGE STUDIES

Land-use change is a key research and policy issue, which provides the theme for significant amounts of cross-disciplinary research in Europe. Despite the existence of a large number of national and Trans-European research programmes aimed at assessing the sustainability of land-use systems, there are few programmes with the explicit task of developing integrated methodologies. Given the growing and often conflicting pressures on land use systems, this area of research has been identified as a major point of focus for national and international policies (LUCC, 1999).

Generally speaking, the effects of the change in land use on global change are still little known in much the same way as the factors, which are behind those processes, are not fully understood. There are difficulties in defining methods of intervention in the regions and in obtaining support instruments for decision making which are fundamental to managing, understanding, monitoring and assessing the (environmental and social) changes resulting from modifications in land use.

Therefore, the land use study involves both the manner in which the biophysical attributes of the land are manipulated and the purpose for which the land is used: forestry, parks, livestock herding, urban areas, suburbia, and farmlands (Turner *et al.*, 1995). The chosen classes denote intent or purpose of use, so knowing this purpose and intent is a manner to understand the trends of change.

Some of the most profound changes in the landscape have arisen from direct decisions by man concerning land use, and these have affected both the quality of environmental resources, such as soils and water, and the sustainability of food production. Land use decisions are based on opportunities and constraints affected by both biophysical and socio-economic drivers. Predicting future land use change requires methodologies that integrate the understanding of the processes affected by these drivers. Because the dynamics of land use and land cover can have biophysical, social, economic or ecological drivers, we must use a cross-disciplinary approach to analyse the different problems. Nevertheless the work departing from the disciplinary perspective of traditional land use studies it must maintain the specificity of each science (Lourenço; Correia; Jorge; Machado, 1997).

Aside from a more integrative approaches for human / environmental syntheses, which must put for a better understanding of the biophysical and social driving forces, it is of prime importance to push further from land cover to land use in a way that we must understand the processes more than the patterns of occupation of a territory.

## COASTAL AREAS

The importance of coastal areas as a study object has emerged in recent times. This increasing importance is due

to the complex activities that are present in those regions. Moreover different scientific research domains contemplate this complexity. Therefore it is of great importance to fix the limits of what is considered as *Coastal Areas* (Lourenço; Jorge; Machado, 1998).

For the natural researchers the coastal areas are related to the influence of the presence of the sea. This conception of coastal areas frames a region, with variations in large of its limits, that includes the coastal plain, the coastal cliff and the coastal plateau. In the immerse area the limits could also comprehend the continental shelves. Therefore, it is a demarcation very related to the influence (present or past) of the sea in the shaping of these areas.

In the frame of this paper the coastal areas are considered as the regions, located near the sea, where he can notice **rapid** and **intense** socio-economic and environmental changes. These kinds of changes are demanding for **fast** and **appropriate** policy responses as well as they act as important driving forces over hinterland regions. They can be considered as "*Hot Spot*" areas in the sense that they are one of the most dynamic and intricate areas of the planet. This complexity involves significant process of population dynamics, which are expressed in population growth, demographic stress and in rapid and intense migrations (hinterland-coast, rural areas-coastal areas).

Also the importance of these areas involves complex Land Use and Land Cover (LUCC) dynamics. These dynamics are shaped by different factors, where we can see the importance of physical drivers (such as geomorphologic, extreme events and natural hazards) and social drivers (population dynamics, industrialisation, external market forces, cultural and life style patterns and policies regulations) and are reflected by:

- Changes in spatial distribution of forests, agricultural and urban areas;
- Changes in environmental functions;
- Changes in performance and management expressed by intensive/extensive use of land that reflects also the land tenure / ownership structures.

This kind of approach to the coastal areas reflects a distinctive way of understanding these areas. In articulation to the relations studied by natural researchers, which give more importance to the land – ocean interactions, these kinds of studies are emerging related to the coast – hinterland interactions.

These studies are become visible as a quite new topic of research inside the Land Use and Land Cover Change scientific network. The approach should be the analysis of different case studies that should provide methodological tools to the various users of the land. Therefore it is very important to develop methodological approaches to the study of land use change in coastal areas. These approaches must apply for the capacities of the remote sensing and

geographical information systems techniques in order to develop and support the research in those areas.

## COASTAL AREAS AS A STUDY OBJECT

The multiple uses of coastal areas constitute excessive and competing demands on limited resources. There are basically two types of conflicts that can be observed:

- a) Those between the natural and socio-economic systems operating, or in other words between natural environment and human activities. For example, it is very important to study the impact of an activity, such as the tourism, over the environment and on the populations that live in a region. The increasing pressure to urbanise the coastal areas could transform a natural region in a chaotic area. Likewise the increasing construction of new highways in those regions has an impact, locally and regionally, and not only over the natural environment, that is far from totally known.
- b) Those within the economy itself in terms of conflicts between users for the limited natural resources available. For example, in a region where the lack of employment is a huge social problem and origins an important depopulation and as an impact over the demographic structure.

The coastal areas are under an urban pressure due the population concentration trends verified in these areas. The observation that the demand of coastal resources are limited in supply and their continued “healthy” existence is crucial to the functioning of coastal areas, suggest the three research questions:

- How do societal driving forces impact coastal resources? Which are the key drivers that will generate or foreclose actions in the future?
- What are the policies, economic and environmental, which are supportive of, and which constrain the sustainable development?
- How might changes under alternative scenarios of economic development and urbanisation affect coastal landforms, land cover and land use?

## METHODOLOGICAL APPROACH

At the moment, both the scientific community and the policy makers perceive the convergence between economic viability and environmental protection as being an important step towards land use sustainability. However, the accomplishment of this perception and its development into a coherent research strategy is not easy; to date the scientific community has yet to provide a robust framework and suite of methodologies within which such strategies can be developed. Mainstream research has adopted approaches only relevant to individual disciplines and the difference in methodologies between disciplines has tended to preclude

effective integration of approaches within single research projects.

Integration underpins the success of the policy-making process, as well as aiding the definition of research priorities relevant to policy decisions. Furthermore, this process needs to involve the stakeholders operating within the landscape: for example, landowners and agricultural managers, local and national regulators, planners and governments, local and national pressure groups, the private and entrepreneurial sector, and the wider public.

The social sciences still lack an appropriate conceptual framework for the understanding of complex interactions between society and the environment. Moreover, the majority of studies tend to concentrate on the effect and impact of man’s actions on the environment, dedicating little attention to the consequences of those changes on human activity. Studies on the role which humanity plays in global change are often carried out within the concept of an *analysis of the human dimension*. Thus, they lose the systemic perspective which considers society as a sub-system interacting with the natural sub-system within the far-reaching and integrated framework which is the global change system (Mesarovic *et al.*, 1996).

The use of this systemic perspective allows the complexity of the interactions defined by the social and natural systems to be incorporated in the analysis and obliges the development of a different view on the relationship of these two systems. This view shows that they interact through logic of reflexivity. In other words, the social systems are changed at the same time as they modify the natural system, *i.e.* the impact of human activity on the environment and the consequences of the latter’s deterioration on human activity cannot be considered separately since they are related in real time.

The scientific basis of this perspective is the belief that integrating physical and socio-economic approaches in the study of land resources and land use systems represents a conceptually correct means of addressing the unifying issue of economic and environmental sustainability.

## The multi-disciplinary approach

It is assumed that the reactions of the different land users will largely determine the impact of the policies in terms of constraints and opportunities for development. This conceptual approach should take into consideration the external driving forces. In other words, the general framework of measures which direct and rule society’s intervention in nature.

Approaches towards the assessment of environmental and policy change impacts on the sustainability of land use systems in Europe have traditionally followed two approaches:

- a) 'Disciplinary approaches', developed from the perspective of a single discipline and using terms of reference and techniques most acceptable to that discipline, often with only a limited consideration of broader influences;
- b) 'Generic approaches', developed primarily within the impacts' community, which attempt to provide forecasts of likely scenarios that encompass the dynamics of complex systems.

Whilst 'disciplinary' approaches provide scientifically exact methodologies for constructing robust frameworks within which assessments of sustainability and policy impacts may be carried out, they often underestimate the range of variability associated with complex systems. Conversely, the 'generic' approaches attempt to encompass the breadth of complex systems, yet often lack the robust methodologies and process descriptions required to accurately forecast future changes, often failing even to predict the current observed variability.

The *multi-disciplinary approach* departs significantly from existing research addressing similar issues. Existing approaches distinguish between the biophysical and economic (Carter *et al.*, 1994), reflecting both the disciplinary perspective of researchers and the difficulty in attracting funding from traditional sources when addressing cross-disciplinary research. The unified approach outlined will more adequately address sustainability in terms of 'cost-benefit' analysis by developing a common baseline for both the economic and the physical attributes of the landscape. Furthermore, this baseline approach will allow a numerical appraisal of the concept of sustainability, which traditionally has been difficult to quantify (Pearce, 1993). In addition, efforts will be made to incorporate social science research and stakeholder inputs, which cannot readily be translated into model form.

Sociological and political structures analysis can help to identify the decisive elements that influence the decision-making process as it affects land use change. For example, constraints, which depend on agricultural structures, may be at the level of education or the level of regional agricultural consultancy. One of the most important elements is the agricultural system created by the Common Agricultural Policy (CAP). The CAP, with its market regulations, has until now dominated production and markets for the most important agricultural products. The market regulations have provided hitherto specified criteria, which stimulated maximisation of production but provided no inducements for farmers to create new marketing strategies for their products. The intervention system has offered farmers (until the reform of the CAP) an almost unlimited guarantee to produce. Farmers were not compelled to ask if there is a demand for their products at all. However, diversification strategies especially require this kind of ability.

The structural economic framework in which land use is carried out often limits the chances of alterations. An EU-policy has, therefore, to conceive several different economic constraints to promote a sustainable land use: the incomes of

farmers, the investments and consequently the economic risk, the rural trade (which is an important link between agricultural producers and industrial processors). An economic analysis has to indicate where the crucial points in the chain of agricultural production, processing and marketing are and how the representatives can overcome emerging problems. What have been the economic restrictions resulting from CAP? What are the economic effects of an ecologically oriented programme?

Because of its policy of intensification, the CAP has resulted in several ecological problems, and the removal of these damages creates costs for society as a whole. We can assume that the restrictions concerning agricultural production will increase. At the same time, there are regions where the dominant trend is extensification; sometimes resulting in abandonment, but always leading to changes in the cultural landscape and human-created balance. Therefore, projects, which are based on the production and intensive use of pesticides and mineral fertiliser, will not have a chance in the future. For an understanding of this complex issue the following questions are important: What are the ecological damages or benefits of a process of land use change? Which impacts modify the quality of environmental resources (water, air, and soil)? What are the impacts on landscape development and landscape quality?

Of the physical global environmental change processes, land degradation (acidification, salinisation, soil erosion, industrial contamination, over extraction of groundwater, etc.) and climate change will probably have the most significant impacts on future land use, although the desire to preserve environmental quality more broadly will also be important. It should be recognised, however, that global change processes are intimately linked with human and policy influences. It seems certain that the world is already committed to climate change (IPCC, 1995), and so the capacity of people, and governments, to adapt to their changing environment is likely to be of great importance to land use in the future.

Another issue relevant to this kind of analysis is also the integration of different scale analysis<sup>1</sup>. If we search for answers at local level we must not forget the external driving forces in other levels of intervention, i.e. the regional and the global framework that influence the local or the individual level. Existing models may be defined as 'horizontal' in their approach to the spatial domain; interactions take place between phenomena operating at a similar spatial scale; inputs/outputs move vertically, either downward or upward, into larger or smaller spatial units. It is current opinion that aggregation and desegregation between the smallest spatial unit of production decision-making in the landscape, namely the farm, allows different spatial scales to be achieved, from the catchment to the national scales.

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<sup>1</sup> Understand the problems related to scale analysis must be a key issue in the study of the interactions nature / society. The different human activities must be evaluated or measured according to the different levels of the spatial and temporal scales (Gibson, C.; Ostrom, E.; Ahn, T., 1998)

This is a conceptually coherent approach, given that aggregation can result in information loss. Furthermore it allows the effects of large-scale phenomena, for instance shifts in market orientation or weather patterns, to be addressed through an assessment of modifications induced at the lowest scale of production. In this context, it is emphasised that farmer decisions are of paramount importance because they underpin the functioning of agriculture, and it is through farmer decisions that policy has an impact on agro-ecological resources. Adequate modelling of this decision-making process is fundamental in achieving the sustainable use of natural resources.

For the integration of the socio-economic perspective in the study of land use changes, it is not enough to collect data of socio-economic type and to present its spatial pattern of distribution, or even its combination with spatial data. The integration of different disciplines requires the close collaboration between these disciplines, already at the stage of defining the datasets needed.

The information to be collected depends on the questions each scientific perspective has to the same object, i.e. land use change, and also on the scale of analysis. Based on the definition of the problems, which need an explanation, each scientific approach has to identify the questions it may deal with, as a contribution to this explanation. And then, dialog is necessary for the understanding of the different questions, and of how the different approaches may contribute to each other's development within the subject. The process is not a simple one, and it is not possible with the work of a single scientific perspective, even if well motivated.

## **THE METHODOLOGY TO THE LAND USE CHANGE ANALYSIS IN COASTAL AREAS**

The application of the proposed methodology to the monitoring and managing of changes in coastal areas aims at the articulation of demographic, economic and social data with information of physical nature (soils and land cover).

These two groups of data will be introduced into the Geographic Information System making for a spatial reading of the information (Fig. 1). The effort of compatibility between the different kinds of data will make possible the integrated analysis. Moreover the GIS software makes possible the quick adaptation of the analysis to the questions that will rise during the course of the research. This procedure would require the characterisation of the region based on indicators (censuses, annual statistics, and data obtained by remote sensing techniques). The use of Corine and Lacoast information will be an important source to the identification of the land use changes.

### **Data collection**

To fulfil the main objectives of this project it was necessary to collect data referent to the land cover and to the socio-economic traits of the population of coastal Alentejo. The data related to the land cover is based on comparison of images obtained from satellite images. This data is grounded on CORINE Land Cover database, which, for Portugal, is

referent to 1985. The other moment of analysis is related to the data obtained by the downgrade to 1975 of similar information achieved by the LACOAST project. This data was an important effort to make a quantitative assessment of land cover/land use changes in European coastal zones (a 10 km large ribbon) especially those due to human activities. This land cover data corresponds to digital maps (scale 1:100 000) obtained from satellite images (1975, Landsat MSS; and 1985, Landsat TM) produced by CNIG (*Centro Nacional de Informação Geográfica*).

The data related to the socio-economic information concerns the Population Census of 1981 and 1991. It was introduced in this analysis, after place / square kilometer grid conversion also supplied by CNIG, after authorization to its usage, of the Portuguese Statistical Institute (*INE*).

Although the land cover analysis was focused on a 10 km large ribbon counting along the coastline, all of these different kinds of data were gathered for divers territorial scales in a way to fulfil one of the most important steps of the proposed methodology.

### **Data Treatment**

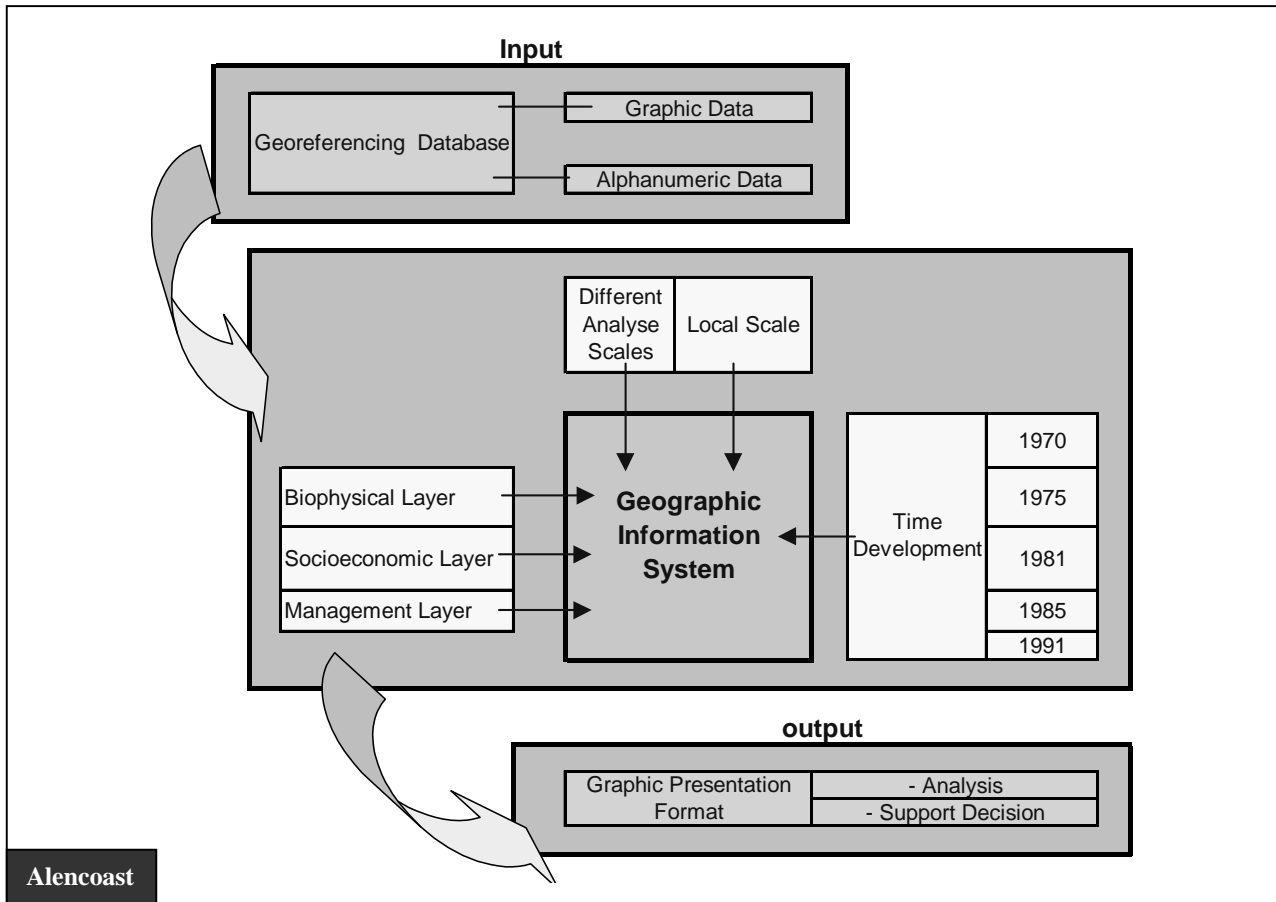
The data related to the land cover was manipulated in three main phases. First it was necessary to organize the legend to the objectives of the study. Therefore it was made a land cover classification from the CORINE legend (third level). Secondly this vectorial information was rasterised constituting a grid of pixels with a coverage resolution of 1 ha. Thirdly it was made a map algebra operation to identify the land cover changes.

In what concerns the socio-economic data the first step was to fit the information to its integration in the Geographical Information System. The second step was the spatial referencing departing from the inferior left corner of the kilometric grid.

The main problems related to the data treatments concerns the different years of analysis of the land cover and socio-economic data. It was necessary to make an effort of interpretation to achieve the objective of understand the land use changes. Also the frequent changes of the statistical survey data categories, identified in Portugal, makes difficult the longitudinal time analysis. These changes of statistical criteria are reflected also in different spatial delineation troublesome the spatial analysis.

Another important question concerns the need to bring up to date the information related with land cover. This fact is very important because the more important changes in land cover in Coastal Alentejo, for instance, are more recent then the data from CORINE.

**Fig. 1 – Structure of the Geographic Information System**



**APPLYING THE METHODOLOGY IN THE ALENTEJO LITORAL**

This study is carried out on two levels of analysis. On a regional level, it is possible to characterise the region using official statistics and remote detection to identify the main dynamics to be dealt with and the main changes in land use. At local level, a study is made of the social actors and of the factors for change identified at regional level.

At regional level the analysis were, therefore, be based on information obtained with instruments for remote detection (satellite pictures and aerial photographs) which permit the collection of information on land use in the coastal area. These instruments also make it possible to obtain data for different periods and to carry out an evaluative analysis of the main changes in land use. On this level, official statistics can also be analysed to collect socio-economic information, which is fundamental for describing the region’s general framework.

These two types of information are complementary and fundamental for the identification of the main dynamics that affect the region studied. It is possible to understanding the regional dynamics related to: the changes in population (Resident population, Age structure, Active population structure and Literacy level); agri-environmental policies

assessment and impacts; planning and regulation; changes in the territory uses (Tourism, Urban, Industrial)

Simultaneously, it is necessary to study the main participants in the land’s use. Is therefore, essential for understanding the motivation of these agents when they use the land to inquire these agents concerning their practices, attitudes and prospects towards change.

The study will identify and highlight three fundamental dimensions, which define a systemic articulation that structures the processes of change in coastal areas: the change in land use; the intervention of the different actors in the territory; and the regional and local dynamics.

*Land-use changes:* The first step will be the identification of the land use changes and the characterisation of the natural framework in which they are involved. The identification of the land use changes will be based on the CORINE Land Cover database and the Lacoast.

*Human dimension and socio-economic and institutional framework:* The methodology involves the main agents for the land use changes and analyses their options regarding to economic activities (agriculture, industry, tourism, services, etc.). The analysis of the actors’ strategies will be carried out regarding the population, agriculture, industry and tourism

statistics. The characterisation of the different groups of actors is an important step of the research, analysing in which way their behaviour and strategies induce the land use changes. The result of this analysis will be also the understanding of the main regional socio-economic driving forces that condition the actors' behaviour and strategies. The land use changes are also framed by a range of national and regional policies and other planning tools essential for the effective comprehension of the process of change.

*An integrated analysis of regional and local dynamics:* The study will emphasise the compatibility between land use and statistical data. For this it is important to refer the existence of Lacoast data and also the treatment of the statistical data already made by the participants, namely the existence of socio-economic data potentially compatible with the SIG analysis.

### Preliminary results

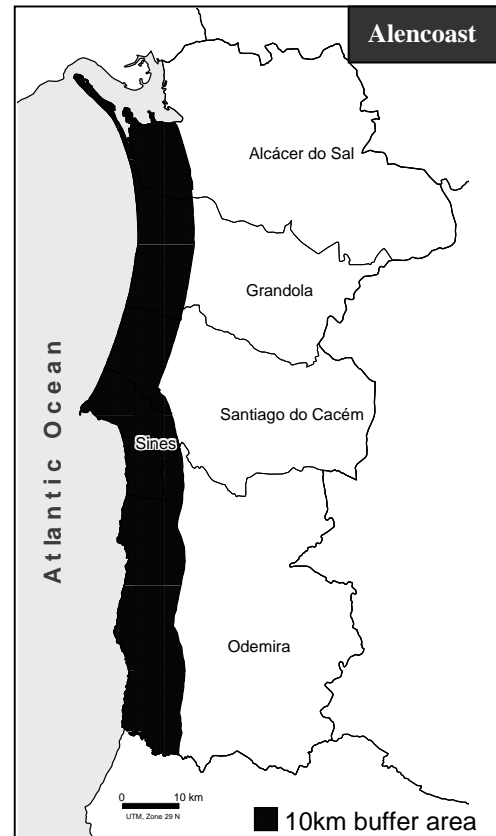
The Portuguese mainland coast (832 km) can be broadly divided in two sections: west coast and south coast (Algarve). The West Coast can be divided in two main sectors located to north and to south of Lisbon area. The first sector can be characterised by an -older and intense urban and economic pressure expressed by a high population density and by a network of diversified economic activities (fisheries, agriculture, industry, and services). The second coastal sector, situated in the region of Alentejo is characterised by a low population density, the dominance of the agricultural activities and services, and by a recent increasing urban pressure in consequence of the tourism activities. A sandy shore on the north and steep cliffs on the south defines the coastline that constitutes, with the adjacent areas, a Natural Park. The problems related to the pressure on this area, mainly due to tourism activities, could damage the present ecological balance. The main institutional constraints to the land use change, causing some interest conflicts between the different social actors, are imposed by restrictive ordinance measures and by the existence of a Natural Park. In this region the industry, which is concentrated around the industrial harbour of Sines, causes the principal problems in terms of environmental degradation.

The southern section of Portuguese coast, located in Algarve, faces problems related to the huge urban pressure resulting from the tourism activities. Here the environmental problems are mainly connected to the absence, during decades, of territorial planning.

In this study the coastal area of Alentejo will be the territorial unit of research (Fig. 2). This fact is justified by two main reasons. In the same region we can identify a remarkable diversity of activities and uses of the territory: the agriculture at north and south; the industry in Sines county; and the tourism related with the existence of small, and almost wild, beaches.

It is also a region where the environmental degradation is, for the time being, restricted to the areas near the industrial harbour of Sines. Nevertheless the increasing pressure over the land towards a higher tourist expansion could, if not well planned, damage the environmental balance expressed by the existence of the Natural Park of Alentejo Coast.

**Fig. 2 – Coastal area of Alentejo studied**



### Bio-Physical and Socio-economic characterisation

In the region of Alentejo the climate is clearly Mediterranean with a hot and dry season which stretches from May to June. The rains are concentrated from November to March. The occurrence of heavy downpours in the spring and autumn and the great irregularities in the yearly rainfall makes it difficult to plan crops and necessary irrigation.

The parent rock is mainly composed by schists and granites and locally by marbles. These rocks are covered, in the Tejo and Sado Basins, by sands and clays. The economical importance of these rocks is reflected, not only by the large size units that extract the cobble, but also by the great number of small and medium size units dedicated to the extraction of sand and decorative rocks.

The variations in soil quality within the region considered here are mainly connected with the changes in the parent rock and with the topography. With the exception of small and narrow alluvial plains, the soils in this region are generally rocky, little developed, with a scarcity of organic



matter, a low capacity for water retention, often highly eroded and not very suitable to agriculture.

The landscape, which is dominated by the huge peneplain of the Alentejo where small ranges of hills rise up, notably the Serras de Grândola, Cercal and Ossa, is marked by an important plant formation (*montado*) which constitutes a system of extensive land use of the agro-silvo-pastoral kind. It results from the selection of species from Mediterranean forest which Man has developed in the last two centuries (Natividade, 1950). It is particularly well adapted to the limiting climate and soil conditions and is made possible by the large dimension of the holdings in the Alentejo.

On the Coastal Alentejo, the *montado* is mostly composed of cork oaks (*Quercus suber*) on account of the ocean's influence that makes the climatic conditions mild. In the interior of the Alentejo where drought is more intense and the temperatures more extreme, the holm oak (*Quercus ilex* and *Quercus rotundifolia*), a species better adapted to these conditions, is predominant.

In terms of land, the *montado* is used for growing cereals in rotation with planted pastures which are followed, generally for four or five years, by a fallow period during which the scrub strata develops. Apart from protecting the soil this stratum, which comprises diverse Mediterranean shrub species, allows for nutrients to be fixed in the soil and for the natural re-growth of the cork oaks. At the end of this fallow period, the land is ploughed and the scrub cut back.

However, various factors have contributed to the degradation of this land use system: The Wheat Campaigns in the thirties and the mechanisation of cereal growing, since the sixties, initiated intensive phases of cereal growing and pasture use that exerts a great deal of pressure on the *montado* in the Alentejo; African swine fever, which spread in Portugal at the beginning of the seventies, led to the end of extensive Iberian pig (*porco alentejano*) farming. For these reasons the economic viability of the holm oak *montado* almost disappeared and it is declining, the density of its trees is diminishing; the latter were generally transformed into vegetal coal, giving way to clean land where the mechanisation of cereal farming was possible (Ferreira *et al.*, 1992). Over the last years the area of cork oak *montado* has stabilised, however, intensive cereal growing and pasture use do not allow for the natural regeneration of the cork oaks and as a result the trees are generally old, in decline and less productive in terms of cork (Daveau, 1995). The recent lengthy periods of drought have also contributed to the general weakening of these trees.

This region with a low population density (large number of municipalities have less than 20 hab/km<sup>2</sup>) is dominated by large and very large holdings and the land of each farm unit is relatively concentrated in a few blocs. The population in the Coastal Alentejo has very irregular distribution reflecting both the differences, which normally exist between the coast and the interior and the attraction of the industrial area of Sines. This region is characterised by undergoing a process of depopulation and ageing of the population, by showing

low employment and income levels and by changes in agricultural practices, namely extensification or even agricultural abandonment of the land.

The population of Alentejo tends to concentrate in the main urban centres, villages and *montes*, which assembled the people and the facilities related to the exploitation of the large holdings. It is near them that the agricultural use of the land is more intensive and often related to situations of pluriactivity.

The five main centres in Coastal Alentejo are the centres of the municipalities: Sines on the coast, Alcácer do Sal, Grândola, Santiago do Cacém and Odemira in the inland; Santiago do Cacém is traditionally the most active centre and the most important with regard to administration. The new town of Santo André has been created in connection to the development of the Sines industrial centre.

In the last two decades there has been an increase, both in Santiago do Cacém and in Sines, in the total active population which is explained by the development of the Sines industrial centre. The opposite is the case in the municipality of Odemira that registered a decrease. At the beginning of the nineties this region had 25% of active people in the primary sector. Although the greatest increase took place in the secondary sector in the seventies, in 1991 it is clearly the tertiary sector that is predominant despite the industrial activities in the region. With regard to the level of education, there is a high illiteracy rate (20% in 1991) and less than 25% of the population has more than the basic school level (Lourenço *et al.*, 1998).

The farm structure is similar in the five municipalities: the number of small properties with less than 20 ha is relatively high but the area occupied by these small units is small. They are concentrated on a fringe along the coast and in two irrigated areas. The large farm units over 200 ha are a minority in all the municipalities but together they cover as much land as the medium sized ones. Near the coast with mid size holdings, the agriculture is characterised by the articulation between subsistence farming and farming which is more geared towards the market on account of the influence of the proximity of the Sines industrial site.

In general, the small units, located both in dry or irrigated areas, are farmed by their owners. Otherwise the large properties have mixed farming forms. With regard to land use, the largest part of the area is covered by *montado*, essentially with cork trees, with a more or less extensive use of the soil. Along the coast and in the two irrigated areas more intensive land use is possible, namely for the production of vegetables and fruit.

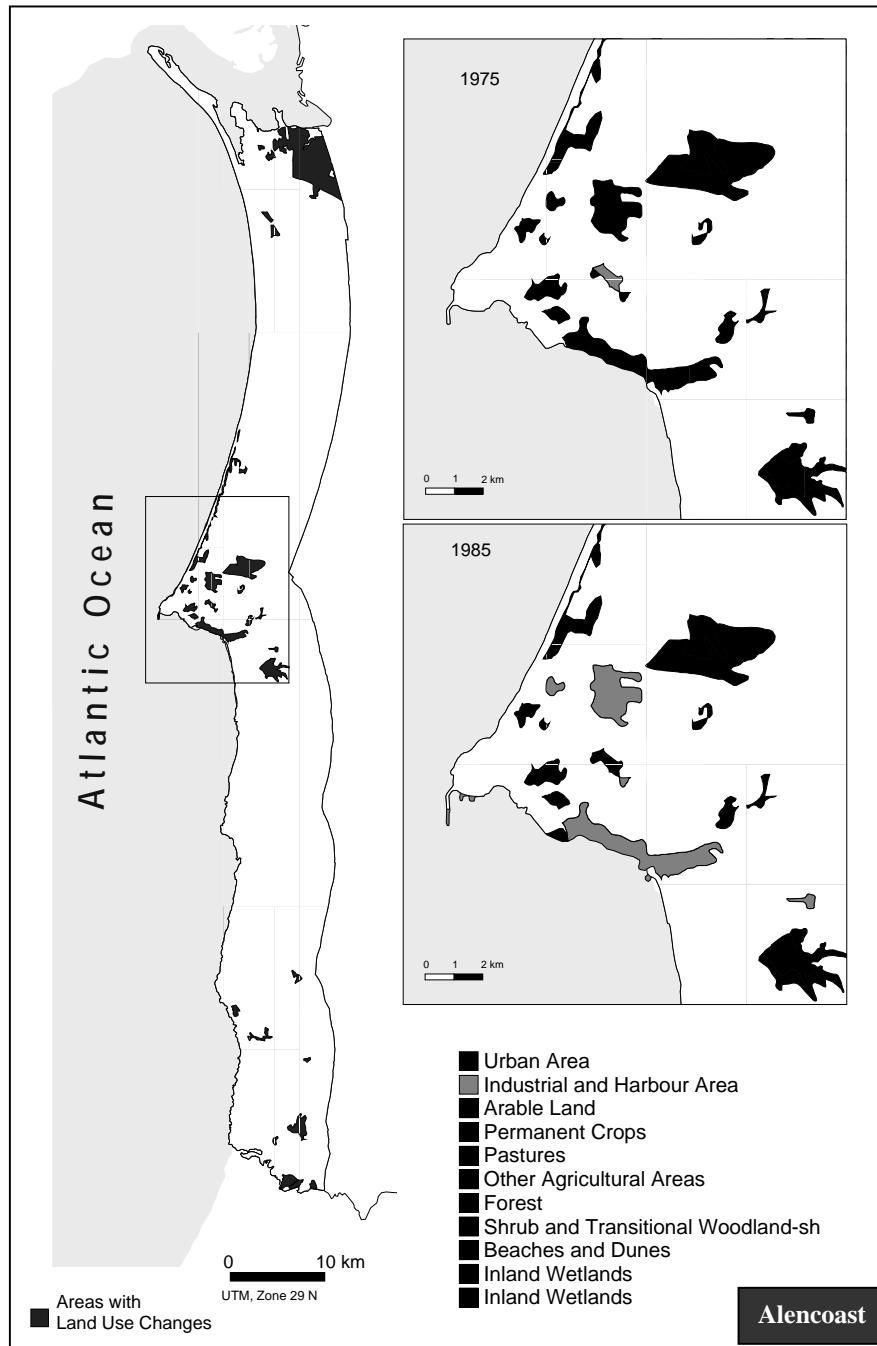
## LAND-USE CHANGES ON THE COASTAL ALENTEJO

The analysis of the land cover in 1975 and 1985, based on the CORINE Land Cover and the Lacoast databases, shows, for the period examined a low rate of land-use changes

(Fig. 3). This fact is related certainly with the weak socio-economic dynamism of this area. The study of many socio-economic indicators denotes that Alentejo is one of the most

peripheral regions of the country (Jorge, 1977; Lourenço; Jorge; Machado, 1998).

**Fig. 3 – Land Cover Changes, 1975-1985, near Sines**



**Source:** Corine Land Cover (1985) and Lacoast (1975) Databases

Generally in Alentejo, in areas already studied by the authors, there are no significant changes in the landscape (Lourenço *et al*, 1997). Over the last years, the processes of change in land use have been characterised by the increase of the extensive use of available land, which corresponds to the increase of the area of natural pastures, conservation of the montado and use, with little expenditure, of areas which

previously were given over to cereal growing. Extensification is a process often associated with the size of farms inasmuch as only a relatively large farm allows for the income levels to be maintained. Apart from this, the support measures for production and the subsidies granted per hectare also contribute to the existence of extensive production systems in which the farm management depends

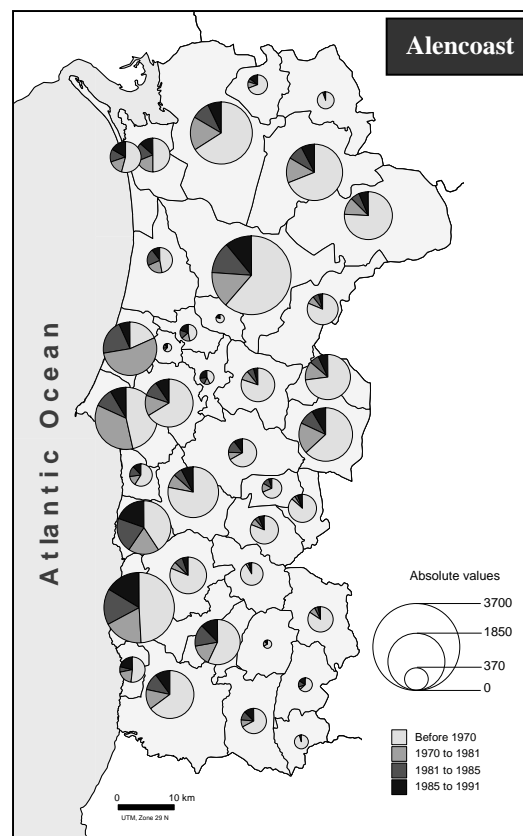
more on the kind of aid granted than market movement. CAP helps the extensification movement because, on the one hand, the aid granted under the guise of agro-environmental measures works as a complement to the farmers' income and, on the other hand, the attribution of grants per hectare contribute towards the choice of extensive production and the reduction of costs related to production factors. More than a global process, it occasionally results in the increase of production costs through more productive activities such as pig farming, vines, market gardening and the purchase of animals without acquiring land, increasing the production costs through fodder or leased pastures.

However it is possible to identify some patterns of change in the Coastal Alentejo. These ones are particularly related with the expansion of the industrial harbour in Sines since 1978. In general terms the area surrounding the expanding urban centre of Sines shows to be the most dynamic. It is here where the land-use changes are more significant. This fact results from the expansion of the industrial harbour, the placement of an electric power plant, the installation of an oil refinery that constituted a significant focus of attraction to the population of the hinterland (Lourenço *et al.*, 1998). Therefore this industrial centre has been, in the recent years, an important infrastructure responsible to the main land-use changes perceived in this region. These land-use changes are represented by the increase of the urban and industrial areas (Sines and Sto. André) and by the enlargement of the harbour facilities. The extension of these areas results on the reducing of the more or less complex patterns of agricultural use of the land, which, were evident in the maps of 1975.

Moreover the most significant land-use changes, which can be perceived in the landscape today, were the result of actions taken in the last decade, after 1985. This fact is very important because these changes in land cover in Coastal Alentejo are more recent than the data from CORINE. Therefore, due to the difficulty in introducing these more recent changes in the context of the analysis carried on, it is of prime importance to bring up to date the information related with land cover. However it is possible to verify that this land-use changes are significantly localised. They concern basically the growth of the small population centres located near the coastline and are related with the increasing of the tourism attraction. This growth can be perceived also by the observation of the buildings construction date (Fig. 4).

Following the identification of the land-use changes, the present stage of the research comprises the association of the socio-economic data with those changes. These different types of information will provide an analysis about which ones are the most associated to the changes in land use. At the same time they should be at service of the integrated methodology and help us to understand, at different levels of analysis, the meanings and the motives of the processes of land use changes.

**Fig. 4 – Buildings, construction date**



**Source:** INE, Censos 1991

However it is possible to propose already some of the main factors of change present in the coastal area in study, which frame this stage of the research:

- Geomorphological evolution of the coastline
- Processes of intensification, extensification and abandonment of the agricultural production systems
- Influences of the industrial and harbour activities
- Growth of the tourism and public administration employment

The consequences of these factors of change can be expressed by the following:

- Changes in agricultural and forestry uses of the land
- Urban concentration
- Industrial areas expansion
- Growth of the areas with tourism use
- Intricate patterns of urban and rural areas

These changes will have impacts on the landscape and can negatively affect both the quality of environmental resources, such as soils and water, and the sustainability of food production. Therefore, this methodological approach can be an important tool to answer and to support the need of a correct territorial planning and the landscape preservation.

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