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An Integrated Approach to Understand Territory Dynamics
The Coastal Alentejo (Portugal)

Nelson Lourenço, Carlos Russo Machado,
Maria do Rosário Jorge and Luís Rodrigues

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Nelson Lourenço, *Universidade Nova de Lisboa*
Carlos Russo Machado, Maria do Rosário Jorge and
Luís Rodrigues, *Universidade Atlântica*

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Summary

This paper aims at presenting an integrated framework for the study of territorial dynamics in coastal areas. The use of Geographic Information Systems made possible the association of land cover data and socio-economic data using different levels of spatial analysis. The Coastal Alentejo (Portugal) was used as case study to identify these territorial dynamics.

Being land cover 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, which has been recently widely recognised. The question is how this integration is possible, and how can it best be achieved to understand the change. 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 land use changes but he also reflects these changes, which were made by him or by other agents that intervene, directly or indirectly, in the land use. Thus we must consider and analyse the impact of external driving forces such as the national and international policies and regulations, being necessary, therefore, an effort to make this kind of analysis at Regional, Local 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 conflicting in these areas. The nature and distribution of human activities on coastal areas result from the action of a range of driving forces Œ 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 cannot 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 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.

Keywords: Integrated analysis, coastal areas, land-use, agents of change

JEL: Q2, Q20

This paper is a brief presentation of the study, "Land use change: A Methodological Approach to Understanding the Nature/Society Interactions in Coastal Areas". The Commission of the European Communities, Directorate-General Joint Research Centre, Agriculture and Regional Information Systems Unit, Space Applications Institute funded this project, which was also full-endorsed by the LUCC Project.

Address for correspondence:

Carlos Russo Machado
Universidade Atlântica
Antiga Fábrica da Pólvora de Barcarena
2745 - 615 Barcarena
Portugal
E-mail: cmachado@uatla.pt, rosarioj@uatla.pt, lrodrigues@uatla.pt

An Integrated Approach to Understand Territory Dynamics
The Coastal Alentejo (Portugal)[1]

Nelson Lourenço
Universidade Nova de Lisboa, Av. de Berna, 26 C, 1069 - 061 Lisboa
nelson@mail.eunet.pt

Carlos Russo Machado; Maria do Rosário Jorge; Luís Rodrigues
Universidade Atlântica, Antiga Fábrica da Pólvora de Barcarena, 2745 - 615 Barcarena
cmachado@uatla.pt; rosarioj@uatla.pt; lrodrigues@uatla.pt

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ABSTRACT

This paper aims at presenting an integrated framework for the study of territorial dynamics in coastal areas. The use of Geographic Information Systems made possible the association of land cover data and socio-economic data using different levels of spatial analysis. The Coastal Alentejo (Portugal) was used as case study to identify these territorial dynamics.

Being land cover 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, which has been recently widely recognised. The question is how this integration is possible, and how can it best be achieved to understand the change. 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 land use changes but he also reflects these changes, which were made by him or by other agents that intervene, directly or indirectly, in the land use. Thus we must consider and analyse the impact of external driving forces such as the national and international policies and regulations, being necessary, therefore, an effort to make this kind of analysis at Regional, Local and Individual Level.

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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 changes 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, 1999).

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 it is far more significant to understand the processes of change then 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 significance 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 include 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 we 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, this kind of studies are emerging related to the coast – hinterland interactions. 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.

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.

However, 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 loose 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).

Understanding the interactions of social systems with the territory is one of the focal issues to the sound knowledge of the territory management. Accepting a systemic perspective allows the complexity of the interactions defined by the social systems / natural systems to be incorporated in the analysis and obliges the development of a different view on the relationship of these systems. This view demonstrate that they interact through a logic of reflexivity, in other words, the social systems are changed at the same time as they modify environment and territory systems, that is to say, 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 (Lourenço; Correia; Jorge; Machado, 1999).

Besides, the territory is not regular neither from the point of view of the natural systems neither if understood as the result of human interventions. Thus, the spatial variety is the product of the diversity of social groups and their actions. It corresponds therefore to different social subsystems (urban, rural, etc.) in which is indispensable to understand the processes that shape them.

The diagram that follows (Fig. 1) attempts to schematically illustrate the methodology developed in this study, fundamentally expressing the theoretical framework of expression of biophysical and socio-economic data at different levels of analysis. This methodological framework was developed to understand the problem progressively, by levels of depth (national, regional and local levels) and using different techniques according to the specific characteristics of the aspects, which are the object of analysis. Despite the difficulties related to the availability and temporal harmonisation of the various aforementioned data sources used, this methodology constitutes an important effort to operationalising the various phases that is necessary for the study of territory dynamics.

The diagram thus reflects the methodology for Measuring, Monitoring and Managing Land-Use / Land-Cover Changes. The way in which it is presented illustrates the architecture against which the various phases of operationalisation of the research must be set.

In an initial phase, the patterns of land-cover and land-cover changes, as well as the socio-economic dynamics are identified at the regional level, which in the case of this study was the Alentejo coastal band.

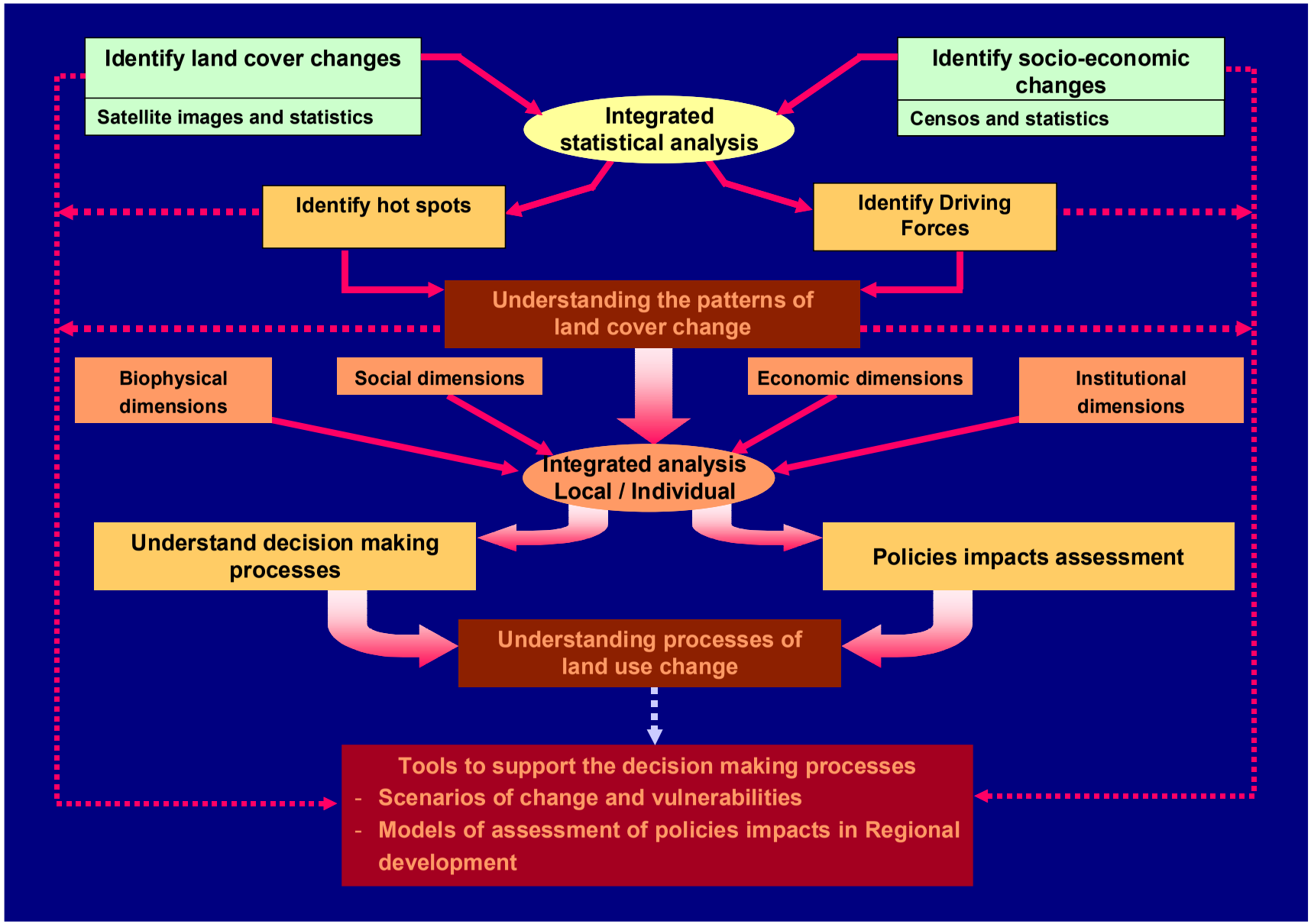
Using various levels of spatial analysis turned possible the integrated study of biophysical and socio-economic data. Recurrent throughout the research project, this type of integrated analysis, permitted in this phase of regional analysis, the identification of the main driving forces and hot spots, the latter being defined as areas where the greatest land-use changes are observed or where their occurrence is predictable, thus contributing to the understanding of the processes of land-cover change. Nevertheless, land-use changes can only be understood in depth through the understanding of the decision-making processes of the various agents of change present in a given territory. In such a way, the following phase of analysis unfolds at the local or individual level and attempts to find out how people make decisions.

It is in this phase of local / individual analysis that we may understand the way in which people adapt their land-use strategies to the biophysical framework and to the institutional framework, thus contributing to the measurement of the real impact of national or European planning and ordinance policies.

This kind of approach is useful either in a more theoretical or in more applied strategies of research, because it is useful in the understanding of the functioning of the systems and it helps in the building of tools to support the decision-making processes in territorial management.

Thus, in a regional context such as the European Union, where strong pressures that lead to accelerated changes are registered, and where these in turn demand adequate and likewise rapid answers, we can see the need for this type of tool that supports the decision-making processes at the national, regional, and local level, and even at the level of individual decisions.

Fig. 1 – Integrated Methodological Framework



Socialising the GIS

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, in Europe, 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 up till now 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.

Another issue relevant to this kind of analysis is the integration of different level analysis. 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). 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.

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.

However, 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 understanding 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.

Since the inclusion of an institutional dimension is one of the bets of this methodology, it must be mentioned that, as Arminda Reis (1993) states, GIS facilitate the thematic representation of the "results of institutional policies and criteria". Hence, conditions to carry out analyses involving data originating from the most varied sources are created. The irregularity of spatial distribution of several territorial management measures may be at the root of the processes of change that in turn, influence or may be influenced by, socio-economic factors. At the level of GIS, this problem is dealt with by systematically surveying the various regional levels, in such a way as to find an adequate answer to the land cover changes.

These hypotheses have contributed towards the understanding of land cover changes, applying the notion of "socialising the pixel" (Geoghegan, 1998), which results from this cross between biophysical and socio-economic variables, that however, encounter several difficulties in terms of reading. The relationship between the land use/land cover and the socio-economic data are rarely direct ("linking people and pixels" Entwisle, 1998). Nevertheless, this association is essential to the methodology since it allows us, at a certain regional level, to make an initial reading supported by the processes of change.

The socialisation of the GIS involves the creation of a local analysis level, where the GIS supports the structuring of the search, making possible to put forward explanations for land use changes. At first analysis, there is a whole set of relations that reveal the potential of "socialising the pixel", which one could use to support assertions that justify land use / land cover changes. For example, there is the growth of the resident population in some parishes and the increase in their urban area; the increase of employment in the secondary sector in some areas and the growth of industrial areas in its surroundings.

It is also possible to make a reverse reading of this relationship, such as, socio-economic data may reflect, at a given moment, a certain change in land cover, a fact that consequently confirm the dynamics of land use. This is what Geoghegan (1998) calls "pixelising the social". For instance, there is an almost direct relation between the land use changes, particularly through the processes of changes with implications on the dynamics of artificialised spaces, and the statistical data concerning buildings. Hence, this type of data not only allows for the confirmation of changes detected, but also helps provide an alternative reading.

The significance of GIS in the study of land use changes

GIS has the advantages of being functional and communicative, hence its use has become fundamental in integrated studies. It constitutes a tool that permits the association of spatial data, respectively graphical and alphanumeric, with different attributes, entities and volumes. The GIS allows a whole set of data analysis operations spatially referenced at different levels, which constitutes one of the main principles of the methodology presented in this work.

The constitution of a geo-referenced database with information collected should render possible the association of biophysical and socio-economic data and their intervention at different levels of analysis, this being one of the main objectives in using the GIS in this kind of studies. What makes these GIS even more relevant is the fact that they permit the construction of dynamic models of geographic reality (Martin, 1991) that makes it possible to reach alternative representations for the production of information to support decisions.

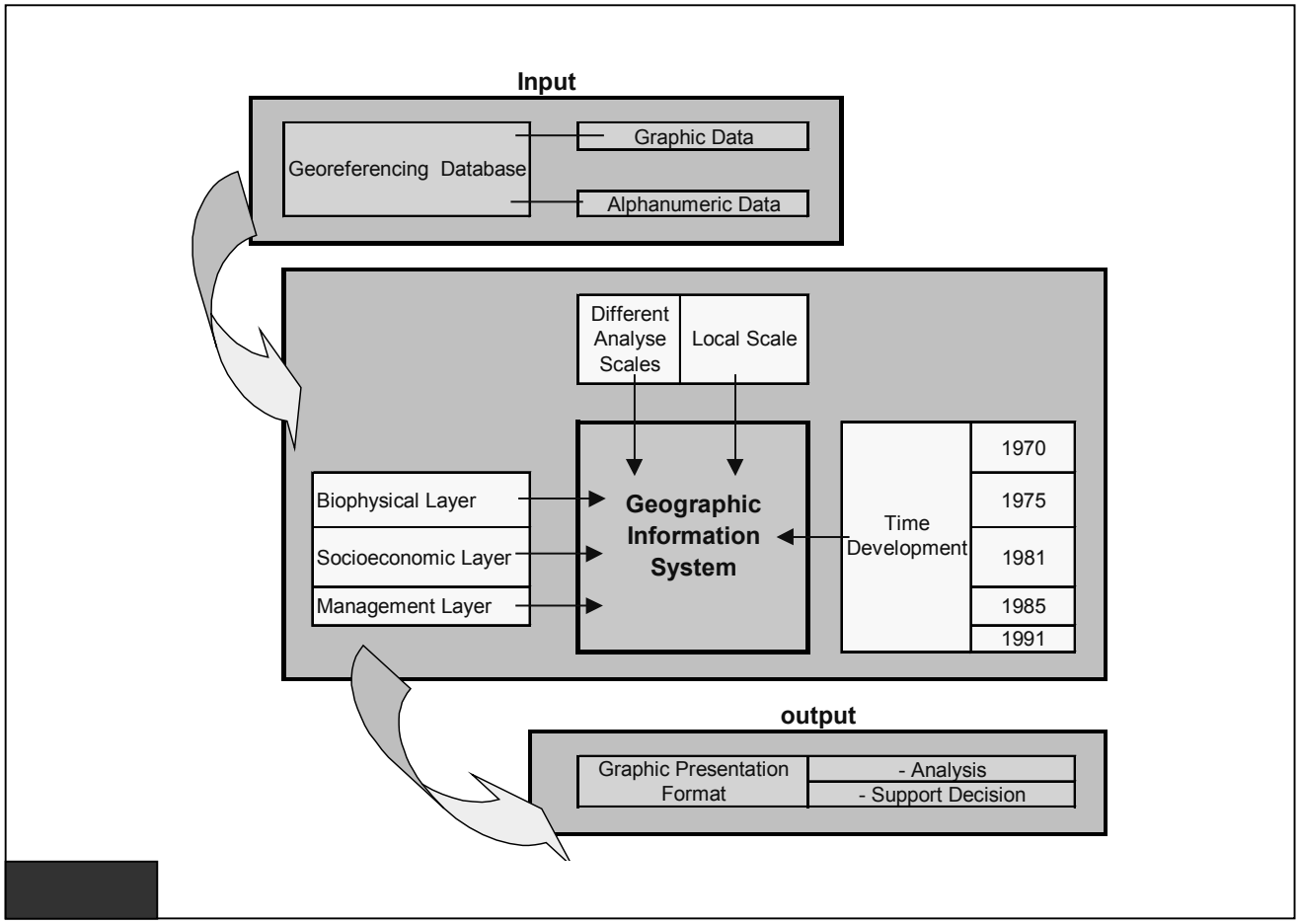
In effect, the use of these *socialised* GIS has already been defended in previous studies (Lourenço *et al*, 1997 and Lourenço, Jorge and Machado, 1997) as indispensable tools in monitoring land use and land cover dynamics, as mentioned above. Aside from the characterisation variables of the various intervening actors in a designated territory, *socialised* GIS, when associated to adequate techniques of sociological analysis, likewise permit the integration of information relative to attitudes and expectations of the individual actors. In this manner, they become essential tools in the construction of systems that monitor and assess policies impact on land use.

THE METHODOLOGY TO THE LAND USE CHANGE ANALYSIS IN COASTAL AREAS

This paper refers to a study carried out on Alentejo. At regional level, the analysis was based on information obtained with instruments for remote detection (satellite images and aerial photographs), which permit the collection of information on land cover in the coastal area and the identification of its main dynamics. These instruments also made possible to obtain data for different periods and to carry out an evolutive analysis of the most significant changes in land use. On this level, official statistics were also analysed to collect socio-economic information, which is fundamental for describing the region's general framework. At local level, an analysis was made of the social actors and of the factors

for change identified at regional level. These two groups of data were introduced into the Geographic Information System making for a spatial reading of the information (Fig. 2).

Fig. 2 – Structure of the Geographic Information System



Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999)

These types of information are complementary and were essential for the recognition of the main dynamics that affect the region studied. It is possible to understand the regional dynamics related to: the changes in population; agri-environmental policies assessment and impacts; planning and regulation; changes in the territory uses. Simultaneously, it is necessary to study the main participants in the land use. Therefore, it is essential, for understanding the motivation of these agents when they use the land, to inquire these agents concerning their practices, attitudes and expectations towards change.

The effort of compatibility between the different kinds of data made possible the integrated analysis. Moreover the GIS software makes possible the quick adaptation of the analysis to the questions that rise during the course of the research. To fulfil the main objectives of the study 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, grounded on CORINE Land Cover database.

The socio-economic data refers to two separate aggregates: on the one hand, the Alentejo (**NUT II)** where the preferential point of reference is the municipality, and on the other hand, *Alentejo Litoral*

(NUT III), where parishes[2] were analysed (Fig. 3). The data collected was organised into two large groups of variables: the demographic variables and socio-economic variables that can be seen as general indicators of development. Demographic and socio-economic indicators used are the resident population, the age structure of the population based on three main groups (the young, the "active", the old), the active population by sectors of activity, the non-active population, the pensioners and retirees, and the level of instruction of individuals.

Among the economic variables are agricultural indicators such as agricultural surface used and average surface per exploitation, industrial indicators such as turnover per industrial sub-sector (extractive, transformation, construction, and public works), and finally, business and tourism indicators such as the number of companies, the amount of labour, and the type of hotel equipment.

For *Alentejo Litoral*, the characteristics of agricultural producers, age structure, instruction and time dedicated to the activity, were analysed only in 1989. In this sub-region, data on buildings were also collected, both in terms of global values (total number of buildings and floors), and in terms of indicators of quality of life, such as the existence of electricity, sewers, bathrooms, etc.

The Coastal Alentejo

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 coastal sector situated in the region of Alentejo is characterised by a low population density, dominance of the agricultural activities and services, and by a recent increasing urban pressure in consequence of 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 constrains to the land use change, causing some interest conflicts between the different social actors, are imposed by restrictive ordnance measures and by the existence of the Natural Park. In this region the industry, which is concentrated around the industrial harbour of Sines, causes the most significant environmental degradation.

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

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 variations in soil quality within this region 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, is marked by the *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, which 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

[2] Local administrative organisation, in Portugal, is divided into two main units: *concelhos* (municipalities), and *freguesias* (parishes).

land use, 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 divers 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.

Fig. 3 – The region of Alentejo studied

Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999)

This region with a low population density (large number of municipalities have less than 20 hab/km^2) is dominated by large and very large holdings and each farm unit is 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. The 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 reinforcing extensification or even agricultural abandonment of the land.

The population of Alentejo trends to concentrates in the main urban centres, villages and *montes*, the last one assembling the people and the facilities related to the farming of large holdings. It is near them that the agricultural land use is more intensive and often related to situations of pluriactivity. The five main centres in Coastal Alentejo are the centres of 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 compound. 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; Jorge; Machado, 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 tend to concentrate 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 more geared towards the market on account of the influence of the proximity of the Sines industrial compound. 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 land use. Along the coast and in the two irrigated areas more intensive land use is possible, namely for the production of vegetables gardens and orchards.

Questions arising from the Regional Analysis: the main societal driving forces

The Alentejo is a region where the process of depopulation and ageing of its population is associated with a strong decrease in the importance of the activities in the primary sector, which is related with the reinforcement of the weight of the tertiary sector, essentially of a social nature. This is a region where the absence of economic activities alternative to agriculture and capable of fixing the population, is causing the population to leave for other regions of the country. Nevertheless, certain municipalities in the *Alentejo Litoral* (Sines and Santiago do Cacém) reveal some capacity to attract labour, mainly due to the economic dynamism stimulated by the industrial pole of Sines.

The main problems of territorial management are related with:

- Intensive agriculture in more or less 2 000 ha (Irrigated Perimeter of Mira Basin) which lead to the extinction of some plant species;
- Marine and atmospheric pollution originated in the Sines Industrial Compound;
- Urban and seasonal tourism pressure over the coast;
- Inadequacy of some forestry projects;
- Random opening of access roads to the coastal zone;
- Illegal fishery and hunting;
- Arson and accidental forest fires.

Resulting from its geographic situation, landscape diversity and reduced human pressure, the Portuguese Southwest Coast accommodates a rich natural patrimony that justified the creation of the Natural Park of the Southwest of *Alentejo* and *Costa Vicentina,* which aims at preserving of the environmental balance of this territory. Therefore, the Park is one of the factors of change that must be considered in the analysis of land use change. However the present and the expected pressures can lead to the disturbance and destruction of coastal habitats, and also to the degradation of beaches by coastal erosion.

Processes of change in the Alentejo

The regional analysis within the framework of the methodology put forward allows for the identification of the main changes as well as the most important factors that explain them in the region analysed. Hence, the main result of the regional analysis previously presented consists in the identification of the processes of change and the main driving forces behind these processes, with

emphasis on Coastal Alentejo: industrialisation and urbanisation resulting from the increase of population pressure in industrial areas and in areas with tourist activities; and agro-forestry activity.

Industrialisation as a driving force is characterised by the growth of a harbour and industrial compound, which, without being anchored on a continuous process of economic development and implemented in a manner sustained by the socio-economic features of the region, corresponded to a temporary project, vulnerable to changes in the international economic context. The oil crisis in the seventies, and its effects on the European and world economy led to the alteration of the project, which initially take into account a combination of factors characterised by the low price of oil and the availability for use of energy resources originating from Portuguese colonies. The main effects of this project in the occupation of the territory has been quite limited to the area of Sines, particularly with the construction of the port and industrial area, and the urban agglomerate created specifically to respond to the housing needs of the workers attracted by the venture Cidade de Santo André.

Urbanisation as a driving force in coastal Alentejo results from the pressure brought about by the population attracted by the port and industrial area of Sines and by the growth of some urban centres with the largest potential for tourist development. If the former type of urbanisation is clearly identifiable in the period analysed, the latter corresponds to a more recent process, and in some agglomerates, beyond the period for which socio-economic data in official statistics are available. Urbanisation is characterised by the increase of population density and consequently, the growth of the area constructed for habitation and infrastructure development and collective equipment in response to the needs of the population. The increase of the active population in the tertiary sector in this region likewise reflects the dynamics of urban growth.

While agricultural and forestry activities are losing significance in the context of the region, they are quite important in the socio-economic dynamics of coastal Alentejo. The relative weight of the population in the primary sector in the region, with employment in agriculture, livestock production, and forestry, is still significant. If retired people still involved in agricultural activities are added to the active population, the weight of this sector is even more significant (Lourenço et al, 1997).

Coastal Band

In this study the coastal area of Alentejo was the territorial unit of research. 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 municipality; 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 planed, damage the environmental balance expressed by the existence of the Natural Park of Alentejo Coast.

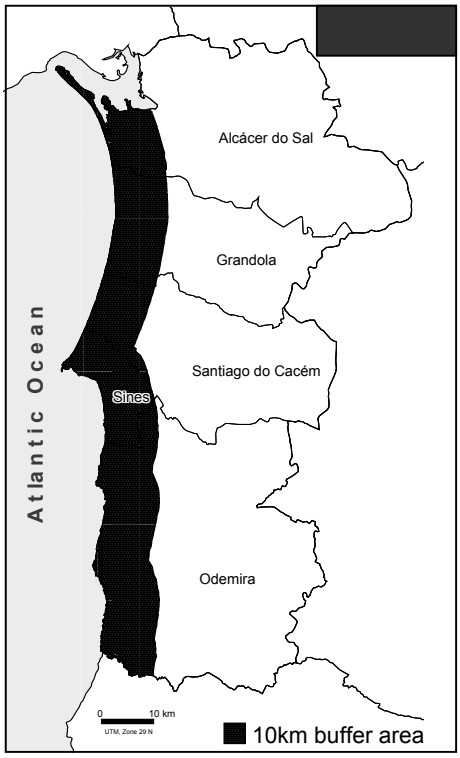
This area consists of a 10 km-wide band, stretching along the coastline (Fig. 4). The Sado River estuary borders it to the north and the Odeceixe River, to the south. Another significant river in this area is the Mira River that crosses this coastal band in the area to the south of Sines. The landscape of this coastal area, especially to the north of Sines, is also marked by the presence of divers lagoons that result from the geomorphologic evolution of the coastline.

The study of this territorial unit is conditioned by the availability of sources of information. In fact, the primary source of data was the project Land cover Change in European coastal zones - LACOAST[3], which consists of the inventory of land use / land cover changes obtained from the comparison of two CORINE Land cover (CLC)-type databases of a 10-km band from the coastline for ten European countries. 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.

[3] The Lacoast project was launched by the Agriculture and Regional Information Systems (ARIS) unit of the Space Applications Institute of the Joint Research Centre, and was funded by the Centre for Earth Observation (CEO) programme Workpackage AS3200 (Application projects in support of the European Commission Services).

This land cover data corresponds to digital maps (scale 1:100 000) obtained from satellite images (1975, Landsat MSS; and 1985, Landsat TM).

Fig. 4 – Coastal area of Alentejo studied



Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999)

Data Treatment and Modelling

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. The socio-economic data were taken from the Population Census of 1981 and 1991. It was introduced in this analysis, after place / square kilometre area conversion, from which resulted a grid comprising small squares of 1 km². These squares show the socio-economic characteristics of the population, such as the resident population, the present population, the age structure, the level of instruction, the sector of economic activity, and inactive population. As for buildings, data on the year of construction, characteristics of the main resistant element (concrete, wood, etc.), and living conditions of housing, were collected.

Data modelling is one of the most interesting forms of data use in GIS since it is fundamental in the obtaining of results. The simplest form of original data modelling allowed the characterisation of biophysical and socio-economic features, the data being processed from the classification of variables, or of sets of crossed variables. The identification of hotspots is directly related to the most major changes in the coastal band throughout the period studied. These changes may be of a socio-economic and/or biophysical nature. Locating these areas is fundamental in determining the classification thresholds for each variable in order to distinguish a particular point. The analysis of the surroundings of hotspots implies the comparison of biophysical and socio-economic factors. As such, areas of land cover changes were first identified; then two buffers (1 km and 3 km) were created around these areas and the socio-economic features were identified in each new buffer polygon created; and finally, these

buffers were compared with the natural park limits. In this manner, hotspots, areas that suffered significant socio-economic transformations were related to the changes on the land cover.

The capacities for the synthesis of visual information were explored in order to obtain the results desired, particularly by creating a set of thematic maps resulting from data crossing. This GIS methodology is based on the clear definition of the data to be included in each one of the analysis levels, i.e. the hierarchy structure of the organisation of information of diverse dimensions, must be at the base of the constitution of data bases of each regional level. Finally, the development of empirical models that allow us to cross all information is one of the objectives of the mastery of the methodology, that can only evolve insofar as it can integrate a more significant modelling component sustained by spatial statistical techniques, aided by spatial analysis functions of GIS.

LAND USE AND SOCIO-ECONOMIC DYNAMICS. PROCESSES OF CHANGE

The land cover in this area is chiefly characterised by agricultural areas (45%) and by forest and semi-natural areas (52%). Other types of land cover are remnants occupying less than 3% of the area studied (Table 1). A quantitative analysis of the land cover changes reveals a very low rate of change between 1975 and 1985. However, it is possible to identify some significant land use dynamics associated to different processes of change. Although they are small rates, the urban and industrial areas underwent some of the most significant changes between 1975 and 1985.

Table 1 – Land cover classes in the coastal area

LAND-COVER CLASSES	1975		1985	
	ha	%	ha	%
Artificial surfaces	1421	1,2	2129	1,8
Agricultural areas	53540	45,4	52638	44,6
Forests and semi-natural areas	61891	52,5	61839	52,4
Wetlands	665	0,6	665	0,6
Water bodies	456	0,4	789	0,7
TOTAL	117973	100	118059	100

Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999) Lacoast, 1975; CORINE, 1985

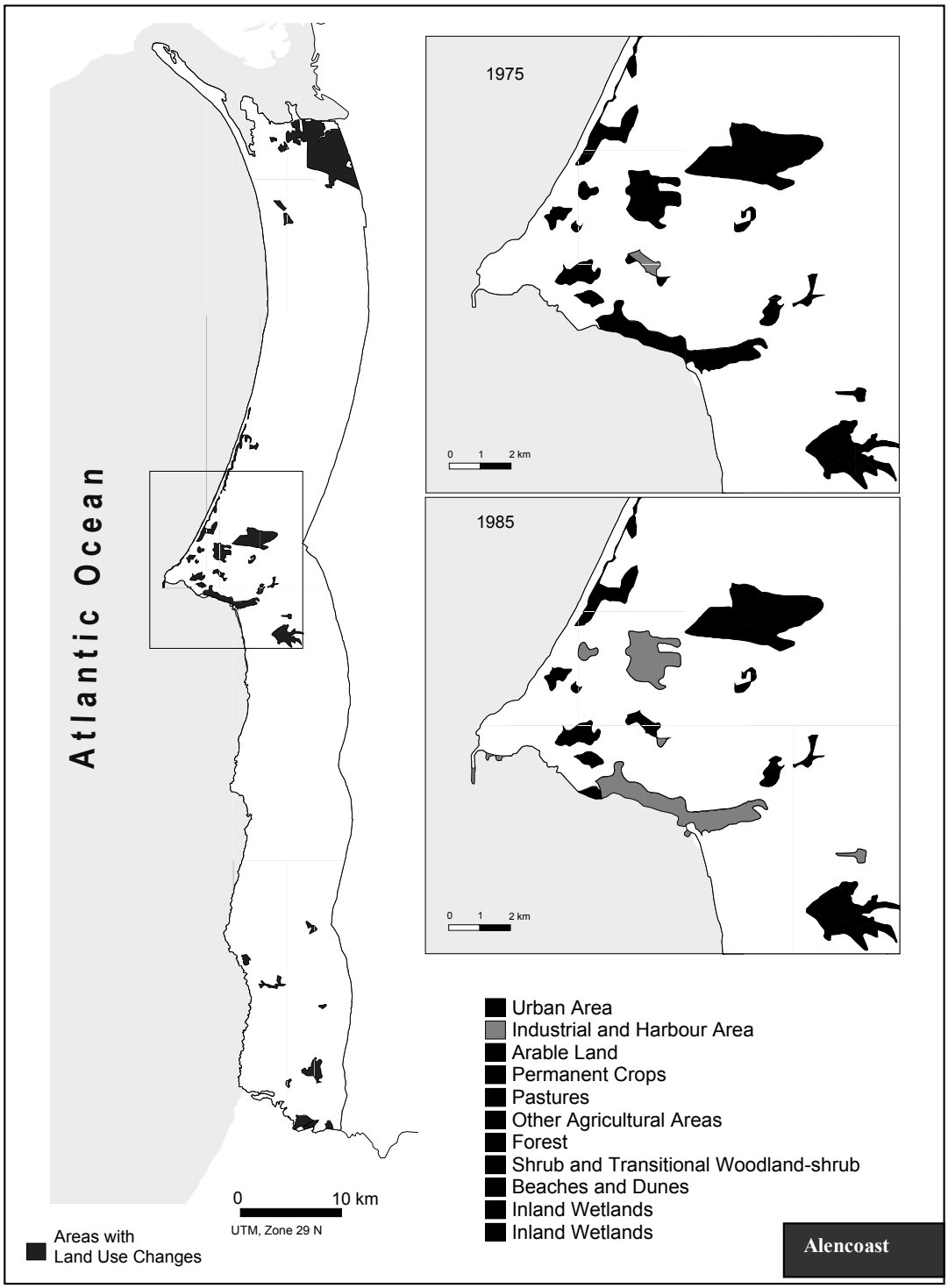
The Processes of Land use Change

However, it is possible to mention some of the main factors of change present in the coastal area in study:

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

Therefore it is possible to identify some patterns of change in Coastal Alentejo (Fig. 5 and Table 2). These ones are particularly related to the expansion of the industrial harbour in Sines since 1978.

Fig. 5 – Land Cover Changes, 1975-1985, near Sines



Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999), Corine Land Cover (1985) and Lacoast (1975) Databases

Table 2 – Processes of Change in the Coastal Band of the Alentejo

Processes of Change
Dynamics in Urban Areas
Non-irrigated arable land decreasing
Dynamics in Industrial Areas
Areas with complex cultivation patterns decreasing
Mixed forest areas decreasing
Dynamics in Agricultural Areas
Arable land decreasing
Areas with complex cultivation patterns decreasing
Agro-forestry areas increasing
Dynamics in Forestry Areas
Cycle of forestry production
Forestry areas increasing

Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999) Lacoast, 1975; CORINE, 1985

Dynamics in Urban Areas

The dynamics in urban areas of the coastal band of the Alentejo are characterised by a significant increase in areas of population agglomerations. However, for the period studied (1975-1985), this growth is visible only in Sines. In this urban centre, the continuous urban fabric registers an increase of 76 ha, and its growth is related with the decrease of non-irrigated arable land. Nevertheless, it can be noted that a more significant growth of the urban fabric occurs after 1985, or in other words, after the date of the CORINE. This growth is visible, with the help of ancillary sources of information such as the 1995 aerial photographs, particularly on the villages situated near the coastline.

Dynamics in Industrial Areas

In general, the surrounding area of the expanding urban centre of Sines seems to be the most dynamic. It is here where the land cover changes are more significant (Fig. 3). These changes result from the expansion of the industrial harbour, the construction of an electric power plant, and the installation of an oil refinery that was a significant focus of attraction for the population of the hinterland (Lourenço *et al*, 1998).

Therefore, in the recent years this industrial centre has been an important infrastructure responsible for the main land use changes observed in this region. These land use changes are expressed in the increase of the urban and industrial areas of Sines and in the enlargement of the harbour facilities. The extension of these areas results in the reduction of the more or less complex patterns of agricultural land use (360 ha), which is evident in the 1975 maps. Likewise, a significant decrease in the area of mixed forest (279 ha) was registered.

Dynamics in Agricultural Areas

The dynamics in agricultural areas of the coastal band of the Alentejo is typified by a net reduction in the area of arable land (irrigated and non-irrigated) and complex cultivation patterns, as well as in the significant increase in agro-forestry areas.

The decrease in area of non-irrigated arable land seems to correspond to an important land use change, given that approximately 70% of the area came to be used in 1985 for forestry or agro-forestry purposes. A land use change is therefore being witnessed.

As for areas with an agricultural use, a significant decrease in complex cultivation patterns is registered as well. In fact, it can be noted that 80% of these areas came to be used for industrial purposes in 1985. This land use change can be seen in the area of Sines in places where we find the

thermoelectric power plant, the refinery, the industrial units related to petroleum derivatives, some sewer and residual water treatment stations, and not to mention the new access roads to the Port of Sines.

Dynamics in Forestry Areas

The dynamics in forestry areas in the coastal band of the Alentejo seem to be typified by two processes; one corresponding to the actual increase in forestry area, and the other related to the land use change associated with the forestry production cycle.

In this manner, only around 40% of the areas that registered in 1985 a change to forestry cover seem to indicate an actual increase in the forestry area. This process of increase in forestry area corresponds to the use of non-irrigated arable land (243 ha) and complex cultivation patterns (52 ha) for forestry production, mainly Eucalyptus. However, this increase in forestry is very slight, corresponding to approximately 0.7% of the forestry area in 1985.

As mentioned above, other changes in the area that may be observed seem to point more to a cycle of forestry production than to an actual increase in area of forestry in the coastal band of the Alentejo. This type of change seems to follow a distinct forestry production cycle that begins with the clearing of cultures in a particular parcel. This leads to a parcel where the rocky substratum (in the area studied, essentially sandy) crops out to the surface. Next, trees are planted and a shrubby layer, sometimes very dense, naturally develops. This contributes to the protection of young trees and the fixation of nutrients in the soil. In a third phase, the trees grow and give rise to a productive forest until they are cut, beginning the cycle once again.

Socio-Economic Pressures on Land Use

Four indicators of pressure on land use were formed based on the analysis of socio-economic variables. This was possible for the coastal band of the Alentejo due to the existence of data disaggregated at the level of the locality and available in the form of a kilometric grid.

Triangulated Irregular Network (TIN) data models were created as a cartographic representation of tourist, urban, industrial, and agro-forestry pressure indicators. These models are based on the possibility of attributing a third dimension to the various phenomena. It consists in the interpolation of data relative to the points (localities / grids) in order to create a set of areas determined by their triangular form. The main aim of this process is to obtain a constant plane from a phenomenon that has a punctual (discrete) expression. This triangulation is based on principles of the topological structuring of relating objects (points – localities). The algorithm used to carry out this TIN had the main effect of easing the slopes in steep elevations. From these TIN models, it was possible to represent summary indicators on a constant plane, which allowed for the association with data on land cover changes.

The above-mentioned data modelling made way for the formation of the following indicators: Urban Pressure, Industrial Pressure, Tourist Pressure, and Agro-Forestry Pressure. The variables selected in these indicators are weighted equally, so that the number of variables present in each locality evaluates socio-economic pressure. Thus, the more variables present in a given locality, the greater the pressure will be.

Urban Pressure

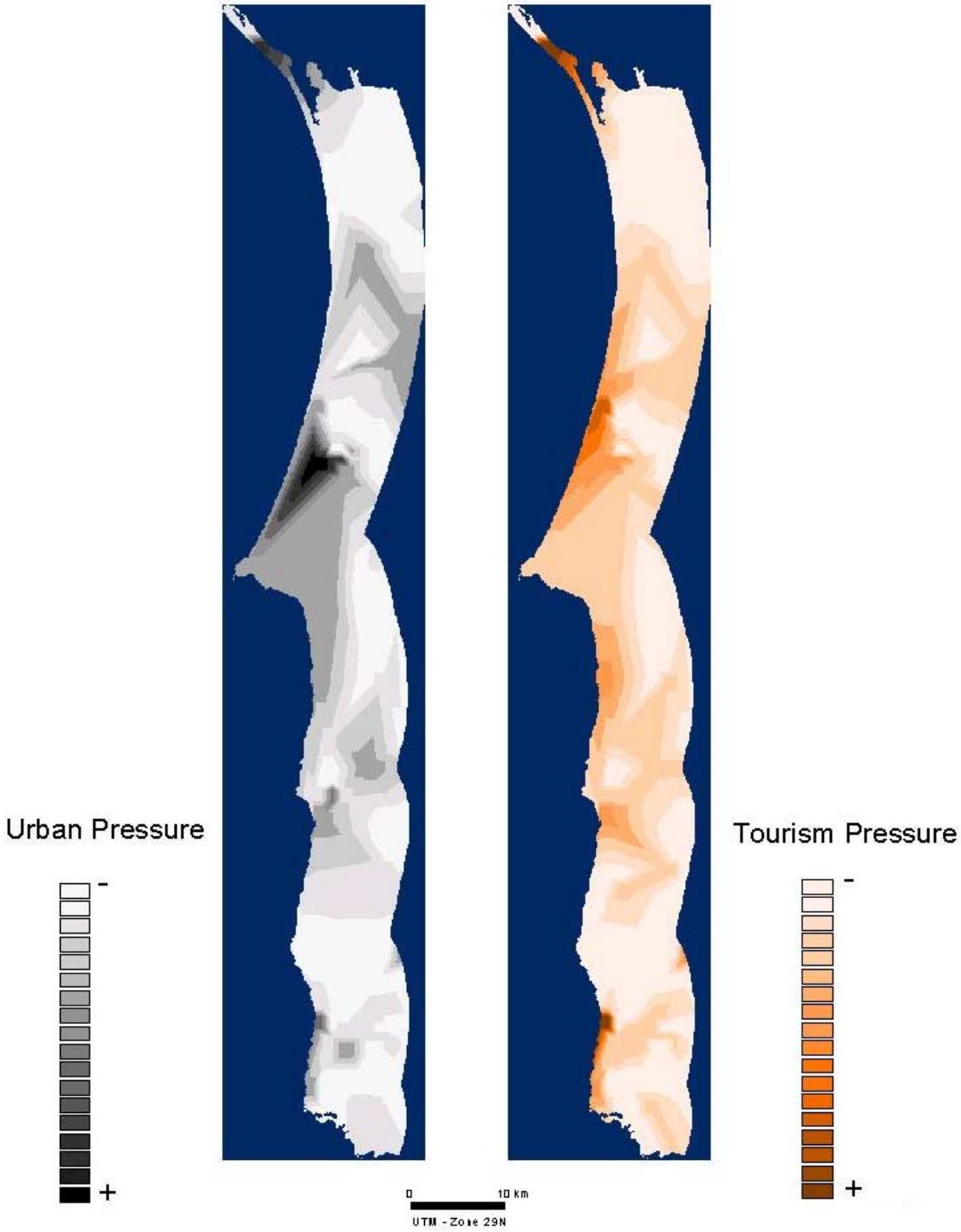
Four variables were used to form this indicator:

- Active population in the tertiary sector in 1991, equal to or more than 50 %;
- Growth rate of the active population in the tertiary sector between 1981 and 1991, equal to or more than 100%;
- Active population in the primary sector in 1991, less than 10%;
- Localities with more than 100 inhabitants and with more than 50 % of its buildings constructed after 1970.

The cross-referencing of these four variables using the Geographical Information System developed for this study resulted in the Urban Pressure Indicator (Fig. 6).

The analysis of this map shows the heavy urban pressure that is felt in the area located between Sines and Santo André. To this area, where the five selected variables are present, the following areas can be added: Tróia, Vila Nova de Milfontes (and mainly localities that are developing in the surroundings of this urban centre, such as Alagoachos), Zambujeira do Mar, and Azenha.

Fig. 6 – Urban and Tourism Pressure 1981-1991 in Coastal Alentejo



Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999)

Tourist Pressure

Four variables were cross-referenced to form this indicator:

- Active population in the tertiary sector in 1991, equal to or more than 50%;
- Growth rate of the active population in the tertiary sector between 1981 and 1991, equal to or more than 100%;
- Localities where the number of secondary households is superior to the number of normal habitations;
- Localities with more than 100 inhabitants and with more than 20% of its buildings constructed between 1985 and 1991.

It was not possible to integrate a variable related with the number of hotels into the Tourist Pressure Indicator, given that this data is aggregated with collective buildings[4]. As such, the indicator essentially reflects one of the dimensions of tourist pressure, resulting from secondary and weekend households.

However, the map (Fig. 6) is very clear with respect to pressure existing mainly in localities next to the coastal line. Thus, the following manifest higher figures of tourist pressure: Tróia, the area adjacent to Lagoa de Santo André, Porto Côvo, Vila Nova de Milfontes, and the coast located between Zambujeira do Mar and Praia de Odeceixe.

It is interesting to note the differences between Vila Nova de Milfontes and the localities developing in its surroundings when this indicator is compared with urban and industrial pressure indicators. While Vila Nova de Milfontes reveals significant tourist pressure, the locality of Alagoachos is subject to greater industrial pressure.

Land Cover Change Associated to Urban and Tourist Pressure

The urban and tourist pressure that is felt in some localities in the coastal band identified in the analysis of socio-economic indicators[5] is not related to any type of land cover change in the coastal band between 1975 and 1985. This is a reflection of the fact that these socio-economic changes occurred for the most part, after the last date of land cover analysis. However, these pressures, which are related to the growth of urban areas, reflect changes observed in the 1995 aerial photograph, and at present, on field[6].

Nevertheless, it can be noted that the areas with the greatest tourist pressure are the beaches, lagoon areas (estuary of the rivers Sado and Mira, and the Santo André lagoon), or a rocky coast marked by very steep slopes. These areas, which constitute a Natural Park, should be preserved, given their landscape aesthetic value, the existence of a unique flora and fauna, and the scarcity of human occupation.

Thus, since it is foreseeable that the increase of tourist pressure in this coastal band shall continue to be felt in places located next to the coastal line, the main land cover changes that will probably occur concerns the increase of urban areas and the decrease of agricultural areas. This scenario corresponds to pressure exerted in this region by various private investment plans that have emerged in recent years with a view to building tourist ventures. Their establishment has however been stopped by restrictions imposed by several territorial ordinance tools such as the Coastal Fringe Ordinance Plans and the Coastal Alentejo Natural Park Ordinance Plan.

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[4] A set of premises intended for a large group of people subject to an authority or a common administration, linked by a common objective or common personal interests. Social welfare, educational, health, religious, military, prisonal, and work institutions, are included in this group.

[5] Mainly in those that are located right next to the coastal line.

[6] While this analysis has not been quantitatively integrated into the study, is a valuable qualitative contribution to the understanding of the more recent land cover changes.

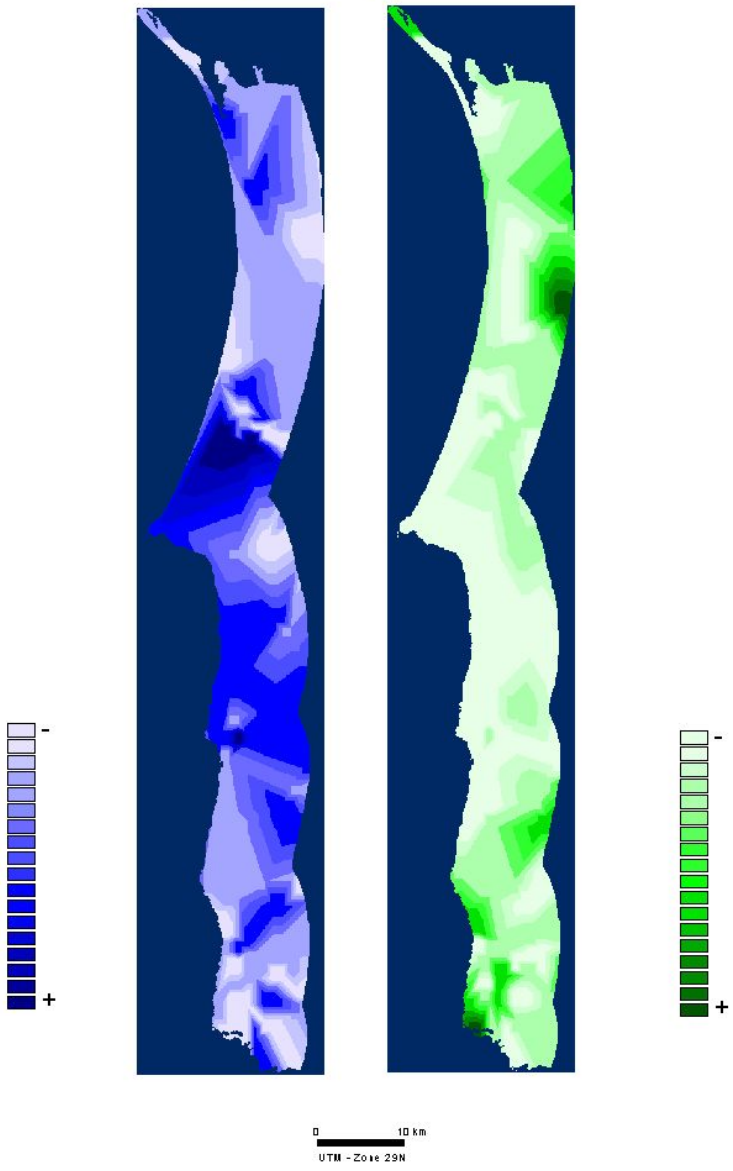
Industrial Pressure

The following variables were used for this indicator:

- Active population in the secondary sector in 1991, equal to or more than 30%;
- Growth rate of the active population in the secondary sector between 1981 and 1991, equal to or more than 100%;
- Localities with more than fifty inhabitants.

This indicator (Fig. 7) shows that the areas under the greatest industrial pressure are, once again, located between Sines and Santo André, and likewise the locality of Alagoachos, located in the surrounding area of Vila Nova de Milfontes.

Fig. 7 – Industrial and Agro-forestry Pressure 1981-1991 in Coastal Alentejo



Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999)

In addition to this, in a vast area of the coastal band the localities show two of the variables selected to form the Industrial Pressure Indicator. This fact is certainly related to both the small industries and activities related to civil construction.

The land cover changes observed in the area of Sines and Santo André, which basically correspond to the expansion of urban and industrial areas, are related to strong socio-economic pressures, particularly due to urbanisation and industrialisation. It is obvious that there is no clear spatial overlapping of these dynamics. However, it is important to note that it is in these places that the two types of dynamics are most intense. The relationship between the expansion of industrial areas and the growth of the resident population and the active population in the secondary sector likewise provide some clues that help to understand the relationship between these two types of dynamics.

Agro-forestry Pressure

This indicator was based on the cross-referencing of three variables:

- Active population in the primary sector in 1991, equal to or more than 50%;
- Growth rate of the active population in the primary sector between 1981 and 1991, equal to or more than 50%;
- Localities where the retired population is more than the active population.

The cartographic representation of the Agro-Forestry Pressure Indicator (Fig. 7) clearly shows the contrast among the indicators above. The areas with the greatest pressure are found far from the coastal line. The following areas are exceptions to this general distribution: Praia de Odeceixe and Zambujeira do Mar. Here, fishing activities must certainly take a more considerable weight in the context of the activities in the primary sector.

The areas located in the extreme north and south of the coastal band have land cover dynamics related to agricultural and forestry use. It is also in these areas that there is the greatest intensity of the socio-economic indicator agro-forestry pressure. The analysis of socio-economic dynamics and land cover at the level of the coastal band explained how the main land cover changes are related to the various socio-economic pressures identified. However, a more detailed analysis and understanding of these processes of change can only be undertaken at the local / individual level of analysis.

At the local level it would be possible to understand, and mainly as far as agricultural land use is concerned, the adequacy of land use strategies regarding biophysical factors such as the slope of the topographical surface, the nature of the soils, and the exposure of slopes. In addition, it would be possible to clearly identify the land use projects that were regulated by regional or local policies and the institutional context, making possible in turn an analysis of their degree of efficiency in the process of sustainable development.

Understanding the link of these biophysical factors with the socio-cultural characteristics of individuals, their capacity to manifest in markets (local, regional, national, and supranational) and in land use policies (national and supranational), and their investment capacity, is valuable in understanding the real reasons behind land use change.

Understanding the factors affecting change: integration of socio-economic and nature dimensions

The analysis of these four indicators of socio-economic pressure on land use shows that there is a sharp contrast between the combined pressure from urban, industrial, and tourist dynamics on the one hand, and agro-forestry pressure on the other (Fig. 8). While the combined pressure of urban, industrial and tourist growth is felt mainly next to the coastal line, the agro-forestry pressure is more evident in the interior of the Alentejo coastal band.

Among the places subject to a greater pressure from socio-economic dynamics related to land use change are the following: Tróia, located in the extreme north of the coastal band; the area next to the coastal line between Santo André lagoon and Vila Nova de Milfontes; and the coast between Zambujeira do Mar e a Praia de Odeceixe. These places are greatly affected by the growth of tourist activities in this coastal band. In addition to these places, the vast area located between Sines and Santo André must be mentioned, where urban growth is related to the development of Sines Industrial Compound.

As has been mentioned before, it is not easy, if at all possible, to find cause and effect relations between land cover changes and socio-economic dynamics[7]. Therefore, we sought to understand how these two types of dynamics are related.

The land cover of this coastal band is mainly characterised by its agricultural and forestry nature, not having suffered great changes in terms of expansion or reduction of this type of land use between 1975 and 1985. The main changes are of a localised nature and are related to growth in urban and industrial areas.

One of the first observations made is that between 1981 and 1991, almost all the localities (represented by a kilometric grid) of the coastal band were located in areas where the land cover is agricultural. Among the localities that were located outside the agricultural areas, one, located in the south of the coastal band disappeared in 1991 as a result of the decrease of its population, and another emerged next to Tróia as a result of the development of a tourist venture.

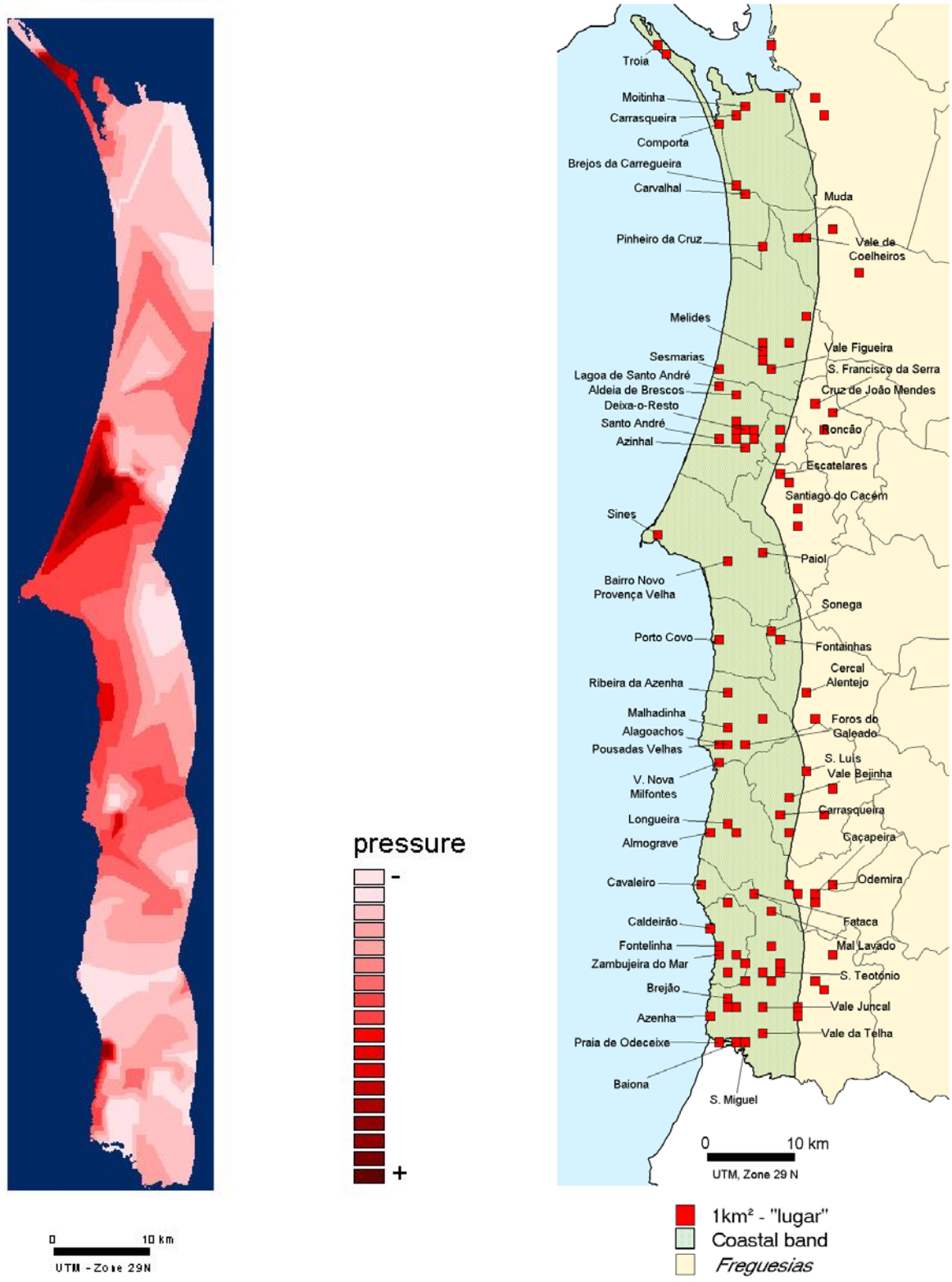
The main land cover changes in this coastal band are recorded in three sectors: in the north, next to the estuary of the river Sado; in the centre, next to the area of Sines / Santo André; and in the south, next to the coastal band limit. The main processes of change can be expressed by the following:

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

These changes will have impacts on the landscape and can negatively affect both the quality of environmental resources, such as soils, water, landscape 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.

[7] Aside from theoretical factors that prevent the establishment of cause and effect relationships between these two dimensions, other factors rendered the cross-referencing of information difficult, such as the time lag between the dates to which the different types of data refer.

Fig. 8 – Combined Urban, Tourism and Industrial Pressure 1981-1991 in Coastal Alentejo



Source: Lourenço, N.; Jorge, R.; Machado, C.R.; Rodrigues, L. (1999)

CONCLUSION

The study of land use changes (in coastal or non-coastal areas) appears to be an essential contributing factor to the understanding of Global Change. In fact, while the problems that these changes cause are diverse, they have one aspect in common: they can put the sustainable development of a region at risk. Thus, in developing countries that have high population growth rates, there is a need to increase and intensify agricultural production, in competition with urban and industrial occupation of the territory, causing serious problems in terms of arboreal vegetation destruction and soil degradation by erosion and pollution.

On the other hand, in industrialised countries (and in Europe, in particular) where there are low population growth rates, the problems resulting from land use change have a diverse nature. The tendency in the European Union for agricultural areas to decrease, brought about by the Common Agricultural Policy, has been accompanied by the expansion of other types of land use stimulated by urban growth and tourist activities. In certain regions, this type of land cover has had a very rapid growth, and without thorough territorial planning, has contributed to the degradation of natural resources and the landscape, putting at risk the economic development model itself.

This study of land cover / land use changes was developed by resorting to a tool of fundamental importance, the Geographic Information System. Recurrent throughout the research project, this type of analysis, permitted in this phase of regional analysis, the identification of the main driving forces and hot spots, the latter being defined as areas where the greatest land cover and socio-economic changes are observed or where their occurrence is predictable, thus contributing to the understanding of the processes of land use change.

Nevertheless, land use changes can only be understood in depth through the understanding of the decision-making processes of the various agents of change present in a given territory. In such a way, the following phase of analysis unfolds at the local or individual level and attempts to find out how people make decisions. As such, the GIS is once again a fundamental tool in the expression and association of a large amount of biophysical and socio-economic data collected at the local level or from the various agents of change.

In this manner, the GIS has shown to be a powerful tool not only because it allows for the expression of large amounts of data of a diverse nature (biophysical, socio-economic, and institutional), but also for the survey of various levels of analysis, thus supporting integrated analyses. As mentioned above, the relation between land cover / land use and the socio-economic data are rarely direct. Nevertheless, the association of these types of data is crucial to a methodology of study of land use changes, insofar as it allows us to make a first reading supported by the processes of change at a given regional scale. The socialisation of the GIS, however, is only fully developed with the creation of a local level of analysis, where it may serve as support for structuring enquiries for agents of change, thereby putting forward more detailed and founded explanations of land use changes.

Hence, the usefulness of this methodology lies in understanding the factors, their dynamics and interactions that are responsible for the dynamics of a given area. It provides also an understanding of the reality helpful to the definition of scenarios of change or vulnerability, by attempting to identify the critical areas of land use change (present or future), and understanding and evaluating the vulnerabilities of those areas relative to those changes.

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(lv) This paper was presented at the First Workshop of the Concerted Action on Tradable Emission Permits (CATEP) organised by the Fondazione Eni Enrico Mattei, Venice, Italy, December 3-4, 2001

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