

DRIVING FORCES OF LAND USE CHANGES IN ALENTEJO AND ITS IMPACT ON SOIL AND WATER

INTRODUCTION

In southern European Mediterranean countries, present levels of environmental and natural resources degradation are mostly the result of a past dominated by inappropriate land use policies, developed under different social and economic contexts, rarely adequate to the environment, to its resistance capacity, or to the sustainability of exploiting its resources.

Most of the studies concerning the impact of agriculture and deforestation on Mediterranean terrestrial ecosystems, define the present levels of natural resources' degradation, as well as the causes and consequences of different phenomena associated with desertification and land degradation. Among others, examples come from Simmons (1989), Thornes (1990), Mannion (1991), Demangeont (1994), Grant (1995) and Stocking (1995).

However, few consider the decisions being taken at the political level – the one empowered to influence long-term land use changes, economic activities, and agro-forestry productions' markets, major drive forces of the dominating system.

Today, there is no doubt that land use changes in rural areas are the result of a long term influence of political and economic factors, related to national and international policies defined to the primary sector. These policies induce changes, under a particular time and space framework, associated with different stages and transforming forces of rural landscapes, not always with the beneficial effects proposed under its basic principles.

But land use changes are not only driven by human factors. As longer time periods are considered, natural factors (mainly climatic and biological) may account with great importance to changing former patterns, and even to influence decision-making processes.

Both human and natural drive-forces will therefore be analysed through this paper, considering a determined space (region Alentejo) and time scale - the 20 years between Portugal's entrance in the European Union (EU) and the end of the III Community Support Framework (CSF), that is from 1986 to 2006, two major stone miles directly influencing land use changes all over the EU.

Such time and space scales of analysis are determinant to its own accuracy, to the choice of methodologies to be used, and finally to drive decision-making processes on further land use changes. Since our time scale analysis is quite short, we will be focusing on the major changing factors and on the few data sets available.

Although 20 years is a very short time period, when referring to natural processes (and specially climatic ones), a brief introduction to climate change and its influence on land use changes will be made. This will take in account the vast research carried out over the last two decades on climate change, its long-term direct effect on land use (and indirectly through ecological changes), quite visible if time scale analysis is enlarged.

Chapters II and III will then focus on human induced changes (clearly the core factor on this subject), mostly important through the application of EU Programmes and Measures under its Common Agricultural Policy (CAP).

Considering space scale, we will now briefly present our target area.

Geographic Frame

Alentejo region is located in south Portugal, occupying a third part of the country, though with less than 5% of its population. It is therefore a vast and depopulated region, with an average density below 20 inhabitants per square km.

It is one of the poorest regions in the EU, with negative demographic, economic and social dynamics. Formerly dependent on the primary sector almost exclusively, it has undergone major changes over the last two decades (see chapter II).

In terms of geomorphology, this region occupies the south western part of the large Iberian structural unit called Maciço Antigo (ancient massif), where metamorphic Palaeozoic formations dominate.

Low, gently hilly lands are the dominant landscape element, brought by extensive flattening processes, with altitudes ranging 200 to 250 meters a.s.l. in average.

This polygenic erosion surface cuts through very different lithologies: clay schists, grauvachs, diorites and gabbros, granites, and quartzites, among others. Extensive Palaeogenic “raña” deposits stand over most of these formations.

Metamorphic formations, dominated by schists, have low susceptibility to chemical weathering, but favour superficial run-off action because of its impermeability. Therefore, drainage network is dense and deep intruded in the relief, while slopes remain steep and straight, originating a “rolling topography”.

Relief forms coming out of this flattened surface are rare, and usually result either of tectonics or of differential erosion. Lithology gives this landscape a certain unity and monotony, originating little developed soils, poor in organic matter, supporting a natural shrub and tree vegetation, mostly composed by well adapted species such as *Cistus spp.* and dry *Quercus spp.*

Soils are mostly poor, with over 50% on classes E and D (bedrock or very thick soils, with no agricultural ability), mainly derived from schists. Soil erosion has extremely high values recorded all over the region, and it is one of the major environmental problems to be faced.

Concerning climate conditions, Alentejo is under the major climatic influence of the Mediterranean. Its climate varies from an atlantic variance at the coast (wetter and milder), and a continental one over most of the region.

It is therefore characterised by a dry and very hot season (stretching from May/June to September/October), high annual temperature amplitude, and a very irregular distribution of rainfall over the wet season, as well as over the years, with very intense flood peaks and with frequent drought periods (fig.1).

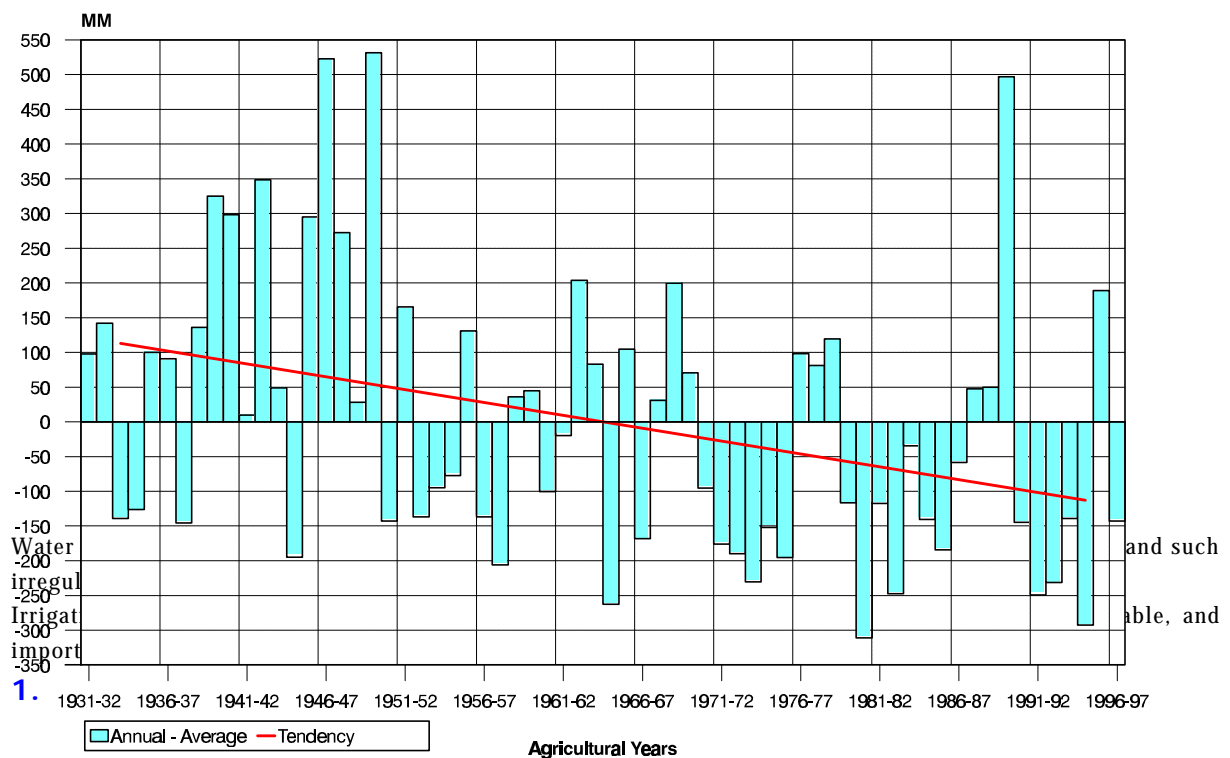


Figure 1 - Annual Rainfall, deviation from average and tendency, Vale Formoso 1931-1997

Climate change in Alentejo over the 20th century

Several authors have mentioned significant changes on precipitation regime and temperature patterns in Alentejo, over the past few decades. Such conclusions were drawn from the analysis of long climatic data series, and from research on other information sources, such as regional newspapers and archives.

One of the most significant changes surely is the reduction of precipitation in Spring. Such decrease mainly results from a strong reduction of rainfall in March. Comparing the climate normal (30-year average period) of 1931-60 with the one of 1961-90, a decrease of 37.5% is detected for Springtime.

This anomaly – Spring deficit – has serious consequences on farming (for example on cereal crops, at the time of grain development, and on natural pastures), and clearly disturbs “natural” vegetation development. Such disturbance occurs over the ideal period for renewing and dissemination of vegetal species, when annual peak is reached for biologic activity.

Another major aspect concerning regional climate change is the increasing concentration of rainfall, with a clear tendency for higher precipitation values on each rainfall event, along with a reduction of total annual events.

Very intense rainfall events are a major cause for very high rates of soil erosion, mainly when such events occur at a time with most land tilled – which is quite common in March-April and October-November. Increase of average temperature and drought periods is also confirmed through historical research and climate data analysis. Alentejo is one of Europe’s most affected regions by such extreme climatic events as droughts, posing very serious social and economic problems, and causing heavy disturbance on ecosystems.

Serious droughts have occurred in the climatic years of 1944/45, 1948/49, 1964/65, 1980/81, 1991/92, 1992/93, and moderated droughts in 1933-35, 1937/38, 1950/51, 1956-58, 1966/67, 1971/74, 1981/82, 1990/91.

The combined effect of a climatic pattern made of great contrasts and a specific and widespread use of land resources by agriculture, has contributed for the present critical level of soil and vegetation degradation, meaning that 25% of the region is severely affected by desertification processes and 45% presents a high sensitivity to desertification.

LAND USE CHANGES AND ITS ENVIRONMENTAL IMPACT OVER 15 YEARS OF EUROPEAN UNION ENGAGEMENT

CAP implementation and its relevance to land use changes

Since Portugal entered the European Union, in 1986, it has been the Common Agricultural Policy (CAP) to drive the major land use changes detected over the past 15 years in Alentejo. First phase lasted up to 1993 (year of first CAP revision), encouraging high productivity and massive investments, together with an increasing integration of enterprises in the new and open European market.

The most important consequences of CAP implementation were the conversion of abandoned land into farming land, with cereal crops reaching marginal and low productivity soils, and a general area increase of olive-groves, vineyards, tomato and sunflower crops, among others, together with a general decrease of forest, shrub and pasture land.

Such changes contributed in large scale to an increasing rate of soil erosion, water resources depletion, water quality problems, and biodiversity loss.

After CAP revision, environmental issues became more important and relevant to policies’ definition, encouraging set-aside systems, low intensity methods, and environmental friendly practices.

Set-aside areas grown larger then ever, forestry area increased tremendously, intensive crops reduced its area, and sustainable farming practices were encouraged, thus enhancing natural resources conservation.

Among the vast range of Programmes financed by the Portuguese Government and the E.U. under CAP, three were of major importance to land use changes as previously mentioned:

- PAMAF Programme: includes all sectors of activity related to the primary sector, and it is economically the most important programme;

- CAP Follow-up Measures - EU Regulation 2078/92: agro-environmental measures, with great potential for the conservation of natural resources, but poorly applied; EU Regulation 2080/92: forestation of agricultural land, with a great impact in terms of area changing to forestry domain;
- PEDIZA Programme, specifically built for the sub-region directly affected by Alqueva Dam Project (see Chapter III.2), in Alentejo; figures shown below prove this Programme's major regional importance.

Figures from IFADAP (2000) on Table 1, considering agricultural investment in Alentejo during 1999, show that investment and subsidies under PAMAF and PEDIZA were far the most important. This last one stands only for about one third of the region territory, which means it has a particularly high value over its sub-region.

Still, prizes given along with CAP follow-up Measures were quite impressive, as well as the rate of subsidy (nearly 90%), justifying a growing interest of farmers on forestation (Reg. 2080) and on the introduction of environment friendly practices (Reg. 2078). As we will see on Table 2, the first is far more relevant both in financial terms and in terms of land use changes.

Unity: thousand euros (.000 €)

	PAMAF	PEDIZA	Follow-up measures	Others*
# projects	2023	1199	339	150
Investment	95.418	111.126	13.113	5.372
Subsidies	64.023	62.074	11.771	3.382
Prizes	1.104	2.753	71.300	8.151

* PPDR (local development), PDAR, PEDRAA II (sectorial programmes), Veterinary Directives, Regulations 3528/86, 2157/95 (Air Pollution), 2158/92 (Forest Fires), and INTERREG II.

Source: IFADAP (2000)

Table 1 - Primary sector investments co-financed by the EU, in Alentejo, 1999

Most of the investments shown were directed towards agriculture modernisation – technology input, irrigation schemes, infrastructures (roads, electricity, etc.), commercialisation and research. Therefore, they do not mean a change of land use, but simply a change of methods and tools.

PEDIZA projects are mostly about infrastructures and research on irrigation - one of the main goals of Alqueva Dam, as we will cover on Chapter III. Its financial importance in such a small area (with very low population density) is quite impressive, but we have to consider that most of these investments were state planned, and that economic efficiency of investments is not yet proven.

Contrary to these major Programmes, one of CAP follow-up Measures (Regulation 2080) is directed to forestation of farming land, therefore accounting for major direct land use changes. Area figures are not yet available, but as we consider investment on the forestry sector, we are able to confirm the importance and financial relevance of this Measure, with a very high rate of subsidy, and an impressive amount given as prizes for the loss of agricultural income. These prizes usually last for a 20-year period, which has a great impact on local farmers, usually with a low investment capacity.

Unity: thousand euros (.000 €)

-	PAMAF - Measure 3	PEDIZA - Measure 2.3	Reg. 2080/92
# projects	158	38	339
Investment	6.143	3.039	13.113
Subsidies	4.027	2.395	11.771
Prizes	-	-	51.480

Source: IFADAP (2000)

Table 2 - Forestry sector investments co-financed by the EU, in Alentejo, 1999

Major changes and its impacts

Up to 1985, cereals and pastures were the traditional main uses of soil in Alentejo, although land abandonment increased greatly since the 60's, when emigration, depopulation, and loss of soil fertility became major factors to the regional economy and society. Such abandonment allowed, though, an increase of resting land and a slow recovery of "natural" vegetation.

Nevertheless, high production costs and climate and soil restrictions were always overtaken by strong subsidising policies and government support schemes, and also by increasing technological input. Cereals remain being grown over vast inappropriate areas, despite European overproduction, decreasing income of farmers and crop productivity, and an increasing public awareness of environmental degradation.

After Portugal joining the EU, financial mechanisms under the Common Agricultural Policy (CAP) have been the powerful "motor" of fast and significant changes of Alentejo rural landscape.

Major tendencies include increasing forestation areas (mainly under Regulation 2080), increasing set-aside areas, and a slight reduction of cereal crops. Although such changes tend to favour natural regeneration and increasing sustainability of soil and water exploitation, practical application of such policies may have negative effects. For example, if we consider the large forestation schemes practised, it has been detected that in most sensitive areas, where land abandonment had taken place and vegetation recovery was happening, most landowners cleared out their properties in order to have them considered as farming land, a pre-condition to benefit from Regulation 2080.

Species used are mainly *Pinus pinea*, *Quercus ilex* and *Quercus suber*, with great dominance of the first - the only of the three mentioned that is not autochthon. The scale of such pine forestation is quite large, mostly over highly sensitive areas, developing a new monoculture, with very little knowledge on its environmental consequences.

Forestation beneficial effects are generally reduced by clearing of pre-existent vegetation cover, heavy soil mobilisation, inadequate planting techniques, and very high densities. Risk of fire may become extremely high under present climatic conditions.

Abandoned land, mostly located in erosion prone areas with high risk of desertification, is being used for hunting and other forestry multiple uses. These areas, usually the ones with steeper slopes, suffering higher degradation and in marginal locations, have a reduced capacity for self-regeneration, and therefore a slow recovery. Nevertheless, such multiple uses tend to favour biodiversity, soil and water resources conservation.

Some important conservation areas were defined (in the present moment these areas are under Natura 2000 Network), but weak management strategies and lack of resources have reduced the policy's efficiency. In many areas, still, because of high value provided by subsidies, landowners tend to farm and grow cereal crops or make other intensive soil uses, such as heavy livestock densities or irrigated crops.

A problem common to all land use changes analysed is mismanagement. Success and benefits from such changes highly depend on soil and climate conditions, used techniques, and species introduced; but it is very often that such policies good intentions are perverted by lack of information and planning, poorly organised management structures, and a strict search for easy and fast profits. Some of the broad impacts detected are generally resumed hereafter.

Soils

Climate change – increased flood peaks directly raise soil erosion rates, increased drought periods and irregularity of precipitation patterns tend to decrease vegetation cover and ecological resistance (thus increasing erosion prone areas), increased temperature means change of biotopes borders and higher fragility.

Land use change – forestation schemes punctually increase soil erosion (during clearings and plantation), though it may provide higher soil protection on the run; land abandonment increase vegetation recover; irrigation schemes degradate and pollute soils more than rainfed ones.

Political and economic framework – there is a strong lack of mitigation actions against drought and desertification, integrated in agro-forestry policies.

Water

Climate change – increased temperature means higher evaporation and less water availability, change of rainfall patterns may cause increased runoff and lower feeding of aquifers.

Land use change – forestation may help regulate water cycle, as well as land abandonment; irrigation schemes cause reduction of water availability and quality.

Political and economic framework – water prices policy (or lack of policy) induces waste and over consumption; lack of basin management schemes is quite visible, although Basin Plans are being drawn.

PROSPECTIVE ANALYSIS

Guidelines of CAP under the III SCF (2000/2006)

The Common Agriculture Policy, which impact under the II Community Support Framework has been previously analysed in this paper, is now beginning its implementation under the III CSF, covering the period 2000/2006.

Guidelines from official EU documents show an increasing tendency to support extensive and low-input farming and forestry systems, reduce productions, and increase food quality.

In Portugal, Programmes AGRO (named AGRIS at the regional operational level) and RURIS cover most of the support given to the primary sector, together with the two CAP Follow-up Measures previously mentioned – regulations 2078/92 (agro-environmental measures) and 2080/92 (forestation of agricultural land).

The latter, regarding forestation, remains economically very attractive for major areas of Alentejo, namely those with low productivity in large properties. Therefore further plantations are expected with similar problems to the ones previously detected (Roxo et al, 1999, pp. 178-182).

AGRO Programme co-financing (Measure 3, article 9) ranges from 30% for fast growing species, up to 80% for nearly all the others. Regulation 2080 co-finances 70% of all expenses for individual farmers, and 80% for groups, and still give an annual surplus for loss of farming income (during 20 years) and management expenses (during 5 years).

Prizes remain given according to the area (per hectare), and therefore, a vast expansion of forestation is expected to continue in most sensitive areas.

Both programmes also pay an extra 10% of total investment, to projects located in protected areas under Natura 2000 Network (legislation: R.C.M. 142/97, D.L. 140/99, D.L. 384-B/99, R.C.M. 76/2000), and in municipalities classified as having high risk of desertification.

Alqueva Dam Project and the macro Regional Development Plan

We will now focus on a very specific case study – the Alqueva Dam Project -, considering its economic and political importance to the region, and its great impact on soil, water, and biodiversity resources. Alqueva is also a major case study for State intervention on land use and for influencing and controlling its future changes.

Alqueva is a multi-proposal enterprise launched by the Portuguese Government and co-financed by the EU, featuring five (5) main goals:

- strategic water reserve, over a basin presently covered by 2 dams in Portugal and 34 in Spain;
- regular and assured supply of water for both domestic and industrial use, specially important in the frequently recurrent drought periods;
- irrigation schemes covering 112.000 hectares (partly through a basin transfer, from Guadiana to Sado), thus doubling regional irrigation schemes;
- hydroelectric power production;
- reversing of the negative demographic and economic regional dynamics;

Flooding an estimated area of 250km², with a total storage capacity of 4.150 million m³, Alqueva is going to be the largest artificial lake in Europe. Its impact on soil and water is quite important, both through direct and indirect effects.

The most important direct effects relate to the flooding area and to mitigation actions being taken – mainly the cutting and clearing of nearly all vegetation in the flooded area, thus assuring a better quality of stored water (by reducing the risk of eutrophication, a frequent problem in local dams due to climate conditions).

The plan and projects for such operations are submitted to the approval of several technical committees of experts, and include mitigation actions covering all environmental hazards detected – namely soil erosion, biodiversity loss, and stream regulation.

Although operations have already started, the Technical Project and its EIA (Environmental Impact Assessment) are not of public domain, and therefore specific actions being taken remain unknown. Informations given by the management company (EDIA S.A.) refer that all vegetation will be cut down and direct soil mobilisation is not going to be allowed. Nevertheless, machine operation and loss of canopy, soil cover, and biodiversity will surely increase run-off and soil erosion, and reduce groundwater supply, although at a short-term time scale.

Indirect effects are mainly a consequence of irrigation schemes – adding over 110.000 hectares to the irrigation area in the region is an old regional ambition, but it will surely pose important problems relating to water quality, soil erosion and loss of biodiversity.

Water quality problems seem to be most important. The Basin Plan for Sado River (INAG 2000) refers to the extreme impact of irrigation systems on water quality over the basin, accounting for 95% and 99% of phosphorus and azote pollutants charge.

On the long run, according to the EIA of Alqueva Dam Project (SEIA 1995), irrigation crops may induce a reduction of soil loss due to its canopy effect, especially during the wet season. The EIA Technical report also refers to a methodology used to conclude on a reduction of soil loss over the irrigated area.

Also according to the mentioned study, local climate will suffer increasing air humidity, as well as a reduction of summer maximum temperatures and other extreme values.

Such conclusions are used to sustain that desertification risk will be reduced, but all of them are highly discussable, based on non-scientific criteria. Further on, the same study refers on its conclusions that water quality problems related to the irrigation scheme depend greatly on the quality of management and knowledge application - and knowledge is still very little concerning the environmental impact of this irrigation system, and its connection to the systems presently operating in the region.

Increased soil erosion may well be an indirect consequence of the disruption and increasing pollution of water cycle, and of vegetation degradation and biodiversity loss, as previously occurred in similar projects.

Considering biodiversity, the project poses a threat of unknown scale due to a planned basin transfer, from Gadiana to Sado river basin, through Alqueva and Alvito dams. Aquatic species, sediment balance and general equilibrium are mostly threatened, and little thought was given on alternatives.

A final reference on biodiversity goes to the Plan being constructed by EDIA, concerning the improvement of vegetation cover on the region around Alqueva, assumed as one of the main mitigation actions conceived to diminish the impacts on biodiversity. These are especially negative along the river valley to be flooded (a stretch over 120km long), include both flora and fauna, and refer to an ecosystem definitely lost. Mitigation actions can only provide tools and resources to restore surrounding ecosystems, improve forestation, and manage the basin area properly – actions only possible and effective on the long-term. ◆

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