# Desertification in Portugal: causes, consequences and possible solutions

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***Abstract***

*Although desertification is not a new problem, world-wide population awareness is increasing. This problem has a greater impact in developing countries, where subsistence agriculture leads to very serious consequences as famine and sub-nutrition. However, desertification also affects the developed ones, because of, among other factors, unsustainable practices in the Agriculture and Forestry sectors combined with poor land management and weak policies. Without proper action, over 50 million people worldwide could be displaced by desertification and land degradation in the next decade.*
*This paper, through a literature review, will approach the problem of desertification, with a special focus on the Portuguese case, its causes and consequences as well as some possible solutions. We conclude that driving forces of desertification can be separated into climate variations and Human activities and that its main consequences are environmental and social-economic. We also point out that, though technical solutions are abundant, part of the solution to this issue relays on attracting population back to the country side, involving the local people on the solution finding processes and increase the social benefits of exploring scarce resources, always bearing in mind the sustainability and the balance between the agro ecosystems and the natural ecosystems.*

***Keywords:*** *Desertification, Portugal, Causes, Consequences, Possible Solutions.*

## Introduction

Since early 1920s the desertification problem has raised the interest of the scientific community. However, only in these last decades it has been considered to be a serious environmental issue, due to the social-economic impacts derived from these phenomena.

The universal definition for desertification is "*land degradation in arid, semi-arid and sub-humid regions, resulting from various factors, including climatic variations and Human activities*" (UNCCD, 1994: Article 1).

Desertification has a greater impact in developing countries, where subsistence agriculture leads to very serious consequences as famine and sub-nutrition. However, this problem also affects the developed countries, and there are unsustainable practices in the Agriculture and Forestry sectors are aggravated with a poor land management and weak policies.

*"Without proper action, both in developing and developed countries, some 50 million people could be displaced by desertification and land degradation within the next ten years"* (Gnacagja, 2008).

Desertification is one of the most important challenges for the 21st Century, and the global warming, combined with the recent global food crisis, and has also contributed to enhance the consequences of this problem. Therefore, this growing pressure, and the acknowledgement of the *status quo* by the world population, requires an adequate response via supra-national coordination.

In 1992, at the Earth Summit, held in Rio de Janeiro, Brazil, the United Nations Convention to Combat Desertification (UNCCD) was created. However, only in 1994 the UNCCD text was signed by all of the UN countries, and only in December of 1996 it was legally adopted.

The UNCCD is therefore a fundamental instrument to prevent poverty, at a global scale. Soil, water and biodiversity as scarce resources are elementary to life on Earth.

Because of desertification different effects in different parts of the world, the countries that signed the Conference text elaborated National Action Plans (NAPs). The NAPs were elaborated in a "bottom-up" approach, in order to promote a bigger involvement and participation of people towards the resolution of their direct and indirect problems. They have also been prepared according to five regional implementation annexes of the UNCCD: Africa, Asia, Latin America and the Caribbean, the Central and Eastern Europe and the Northern Mediterranean area (i.e., the Annex IV countries – where Portugal is included).

At the European Union level, all countries have signed the UNCCD text, and the European Commission is preparing a strategy for soil protection. This strategy is focused on soil as a vital resource and essential for food production, as well as its environmental role (natural ecosystems). Portugal was one of EU countries that first subscribed the Convention text. At the 17th June of 1999, the World Desertification Combat Day, the National Action Programme to Combat Desertification (PANCD) was presented as a political priority. However, only three years later, a commission was

formed to carry out the implementation of the actions planed. The specific objectives of the PANCD were centered in the preservation of water and soil, as well as in the fixation of people at most abandoned areas, the recovery of the affected areas, the population awareness and their integration in the social-economic policies.

A high level of degradation of water, soil and biodiversity were diagnosed on several scientific studies (Sequeira 1998). This situation is aggravated and more visible at the regions where the exploitation practices of natural resources are inadequate. This situation is acute in Southeast Portugal (inland Alentejo and Algarve).

Some indicators have been set, such as climate susceptibility to desertification index, soil susceptibility to desertification index, vegetation susceptibility to desertification index and soil susceptibility to desertification index based on soil use. Combining this set of indicators, the desertification susceptibility syntheses index is created (Imenson, 1998).

The information systems are essential to follow the evolution of desertification and identify the areas of higher risk, in real time. Therefore, Landsat and European Space Agency (ESA) data were used to monitor the situation through satellite images. The resolution allows local scale intervention. DesertWatch, which also includes Italy, Greece and Turkey, will be watching the whole country, thus providing the tools to political decision makers, in a prospective attitude (Seixas, 1998; Rosário, 2008).

Portugal is the most affected country in the European Union, followed by Turkey and Italy. And, according to DesertWatch, the desertification has spread to a third of the national territory and due to physical, ecological and social threat factors, the situation is rapidly moving towards a total of two thirds of the territory susceptible to desertification in the next two decades (Rosário, 2008).

In order to act in a preventive way and stop the desertification problem from spreading to the rest of the national territory, the needs for an effective contingency plan urges.
Due to the lack of financial funds for the PANCD, the main activities taken by the coordination of the Plan are focused on informing the populations in the most affected areas about the negative impact of inadequate Human activities regarding

desertification, and studying the causes, consequences and solutions for this problem, at a national level.

Through a literature review, the main goal of this paper is to contribute to the people's awareness of the problem, by promoting discussion on its causes, consequences and possible solutions.

**Causes**

The driving forces of desertification can be separated into climate variations and Human activities, according to the UNCCD definition. It is known that Human activities have a great influence in the climate and vice-versa therefore these two components are directly linked together.

Portuguese climatic data indicate that precipitation, soil humidity and water recharge of underground reservoirs are diminishing (Veiga da Cunha, 1992 cit. Sequeira, 1998). Climatic data also indicate (Espírito Santo, 1997 cit. Sequeira, 1998) a strong diminution of spring precipitation and concentration of rainfall in short autumn periods. This leads to an aggravation of the annual and pluriannual drought periods. Resistance to drought is also diminished especially in areas with degraded soils.

Most of the causes for the spreading of desertification are related to Human activities, mainly the over-exploitation of water and soil, uncontrolled wood-cutting, mining and excessive use of agro-chemical products. This reflects an inadequate use of agronomic and forestry techniques as well as poor land management and policies. In aggravation, every year, large scale fires combined with pollution and drought are registered in Portugal.

Local farmers misuse land due to lack of knowledge about long term consequences of their actions and about adequate techniques to prevent erosion and to restore degraded soils. Public policies are also responsible when no direct or indirect incentives are offered to the correct landscape management and often offer incentives to inadequate agronomic practices.

In Alentejo, since the beginning of the wheat campaign in 1929, intense soil mobilizations, extensive agriculture mechanization and shortage of land resting periods destroyed its superficial layer; cumulatively, intense erosion processes resulted on soil fertility loss. Small farmers got bankrupt and massively migrated to big cities. The agronomic reform derived from the 25 de Abril revolution promoted the use of marginal areas with low agronomic value, aggravating soil erosion processes, soil fertility loss, as well as vegetation degradation and biodiversity loss. Livestock (cows, sheep, goats and pigs) is produced in pastures beneath Montado, in drought years their excessive number leads to soil denudation and consequent erosion. The high charcoal value during the wheat campaign and 2nd world war also contributed to cork and holm oaks from Montado cutting and subsequent inadequate cereal culture in these deforested areas (Oliveira, 1998). Large scale fires combined with drought also contribute to this degradation of the natural ecosystems and to a misuse of natural vital resources, like water and soil.

The European agronomic policies (PAC) were inadequate to local realities and needs (for example: *Pinus pinea* subsided plantation in southeast Alentejo region). European subsides were commonly the most important factor in the decision making process of land use by farmers (as an example: wheat continues to be cultivated even when it's commercial value is not compensating; live-stock number is artificially maintained high due to subsides based on number of animals/area) (Roxo *et al*., 1998).

Any strategy must aim the restoration of the equilibrium between agro ecosystems and natural ecosystems. We should learn with History, before it´s too late. Agriculture resulted from the need to control Nature and satisfy human needs, and allowed cities and empires to grow. But the Fertile Crescent is not fertile anymore and Egypt or Central America, where great civilizations once prospered are nowadays affected with great environmental issues.

## Consequences

The consequences can be separated into:

- Environmental;
- Social-economic.

## Environmental consequences

The direct environmental consequences of inadequate Human activities have led to unsustainable agronomy and forestry practices, and to desertification.

The cultivated and forest areas decreased due to the loss of agricultural and forestry potential, in the affected regions. This means the organic matter decreases, and so does the soil value. With less vegetation coverage, more soil is exposed to the natural elements. This leads to soil erosion, to vegetation cover degradation, depletion of groundwater, salinization, suppression of the fallow periods and other phenomena that cause long term damage (Hare *et al*., 1992). The water use efficiency rate is reduced. This means the water is being wasted, and that the water resources decrease at the areas affected by the desertification process (Sequeira, 1998).

The scarce water resources also decrease in quality, due to the pollution that is caused by this waste, through run off polluting the rivers and through infiltration into the aquifers and underground water channels. This means the water cycle is suffering from an extended damage.

With more and more limited water resources, in quantity and quality, the soil becomes dry and impermeable. This means that floods will occur more often and the loss of soil increases.

Ultimately, the environmental consequences resume to the loss of vegetation cover, landscape acute modifications and biodiversity loss.

**Social-economic consequences**

One of the most obvious social-economic consequences is the migration flux that takes place from rural areas to the urban centers at the coast line.

The rural exodus results from the lack of opportunities in these interior regions and it means that family disaggregation increases.

This flux of people creates problems at their origin areas and also at the areas that receive them (Hare *et al.*, 1992).

Because most of the population that migrates to the big cities, in search of new opportunities, is the gross of the active population in the origin areas, this means that the interior regions tend to be more and more characterized by aged population, and less wealth is generated, thus increasing the poverty in these regions. As a result, economic losses emerge as well as losses in the rural dynamics (Lourenço *et al*., 1998).

At the receiving areas, the urban infra-structures, already over-charged, tend to get worse (i.e., mass transport systems, education and health care). This is also aggravated by the lack of a good land management, and buildings start to arise without any conscience of order or logic, creating inefficient concrete jungles and the life quality decreases in these cities. The desertification problem can also be related to the increasing unemployment and urban violence, because most of the migrants will compete with the receiving community for jobs, and the level of education in the interior regions being generally lower than in the big cities most certainly does not help them to adapt.

These migrations create a vicious cycle where the rural potential is being wasted while the urban efficiency is decreasing. In Portugal people identify desertification with social-economic consequences rather than with environmental consequences.

**Possible Solutions**

In Portugal, the main causes of desertification have already been clearly identified (Roxo, Mourão and Casimiro, 1998; Pereira *et al* 2006). The major economic activities have been concentrated at the coast line, during last decades, which led to the abandonment of the inner Regions of the country. This situation also led to degradation of these rural regions and unbalanced the biodiversity.

With less population in the interior regions, the natural ecosystems become fragile. Large scale fires combined with drought also contribute to this degradation of the natural ecosystems and to a misuse of the natural vital resources, like water and soil.
Investments in the Portuguese countryside do not appear to be attractive because the land productivity potential has been reduced. Also the low population density is a problem for implementation of new businesses. Investments are then focused on large urban areas, to satisfy the needs of their increasing population. This is pushing towards a growing unbalanced situation.

The need to implement a new integrated strategy of rural and regional development is urgent (PANDC 2003). This must be aimed at restoring the equilibrium of the relations between the agro ecosystems and the natural ecosystems, which has been broken.

This equilibrium implies the sustainability of Human activities, in the interior regions as well as in the big cities. It must involve a balance between environment, social and economic spheres, with an active political orientation. The sustainability of such actions is a new approach and one of the highest challenges for the 21st Century, as referred by Sardinha (2008): "*The persistence of unresolved stabilization of these fragile lands and the substantial reduction in the provision of ecosystem services as a result of intensive use of resources, incapacity of wide spread adequate technologies for providing increased supply of food, forage and fuel, water scarcity, and climate change puts desertification in among the greatest environmental challenges today and a major impediment to meeting human needs and attainment of the Millennium Development Goals. Scenarios for Climate change add up to environmental degradation associated with desertification bringing new threats of intensification of trends in the expansion of these degraded areas*".

To deepen research and knowledge to reverse this situation is a constant need. Agronomists and Forestry Engineers must provide their contribution with technical solutions to a sustainable model, and engage the mitigation of desertification through the sustainable agriculture/forestry systems (SAS).

Though technical solutions are abundant (for example Sequeira 1994), we focus the present discussion on the economy and management of the natural resources. Aiming at attracting population back to the countryside, involving the local people on the solution finding processes and increase the social benefits of exploring these scarce resources, always bearing in mind the sustainability and the balance between the agro ecosystems and the natural ecosystems. This same aspect is underlined by Pereira *et al*: "*The issue is to keep those rural landscapes alive, developing new uses for the natural local resources that are compatible with the economic living of populations, the conservation of resources, and the leisure use by the growing urban world. Therefore, policies have to be found that stop or, better, reverse emigration and aging of populations. Because in large areas the remaining population is not anymore sufficient to keep a demographic balance and to maintain social and economic activities at a minimum standard level, including schools, health services and market of essential goods, the solution of the problem cannot be found with the local people alone but as a matter of interest for the society*" (Pereira *et al*., 2006).

The ecological and the economical optimums have been considered antagonist for these last decades, and the maximum profit has driven most of the Human activities. But the economists and politicians are now aware that these optimums can be complementary in a sustainable point of view. Therefore, a new optimum is being searched, somewhere in between the ecological and the economical optimum. This point is called the social optimum.

The social optimum is the point of balance, where greater revenue is obtained for the society, through human activities. This point is obtained when externalities are included in the profit function. This is done by identifying the production levels which lead to the maximum profit for the society as a whole. Thus, the real challenge is to develop ways to account for the identified externalities that led human activities to become unsustainable.

A good example of success of this new approach is the CO2 market that was created with the Kyoto Treaty, at a global level. Maybe, a market of the elements has to be created, for air, water, soil and fire, and a good resource management, at all levels.

This means cooperation and coordination at a global level, between the major economic blocks. It also means that the Common Agriculture Policy (CAP) has to aim at improving the life of the population in the countryside. In fact, the recent CAP reforms have introduced the tendency to change funds from market support policies (first pillar) to rural development (second pillar).

It is clear that at regional and sub-regional levels there must be an evaluation of which *Sustainable Agro/Forestry Systems* are adequate, as they differ from region to region. These must be supported, while the unsustainable practices must not be encouraged and must not be supported (i.e., irrigation techniques highly consumption of water in the drylands).

It is essential to thoroughly apply and use existing means to monitor the efficiency of the actions, like the DesertWatch program and various indexes (Imenson, 1998). For the Portuguese case the PANCD also recommends several different technical solutions and indexes for the monitoring issue.

According to the DesertWatch program, the most susceptible regions have been identified, and they correspond to a third of the national territory. These areas should be considered protected areas, with special actions aiming to diminish the impact of desertification. Scientific studies should be carried out in order to obtain knowledge about the species that can adapt to the soil and climate conditions present at the most affected areas. The original biodiversity should also be studied, so that it can be recovered.

According to the PANCD coordinators, it is expected that a total of two thirds of the territory will be affected during the next two decades. The areas which tend to be affected by desertification (one third of the territory) should be treated in a preventive way as soon as possible, rather than in a reactive way two decades later.

**Discussion**

Desertification is an issue that has to be mitigated and combated at all levels of social organization. Unsustainable human activities produce a global impact, not just a national impact.

Though free markets have proven their effectiveness on wealth creation, some degree of regulation is essential. Desertification should be seen as an externality of unsustainable human activities. As such, markets alone are not effective to guarantee the maintenance of potential uses of lands in risk of desertification. The case of Portugal, mainly the inland southern areas, is a clear example of this.

Any plan, aiming to restore the balance between the agro-ecosystems and the natural ecosystems must be centered in sustainable agriculture/forestry systems. Therefore, these systems must be economically viable (food production and profit in the present and in the future), environmentally healthy (biodiversity and fauna conservation), socially accepted (appropriate systems for the people that invest their effort and resources) and with political support. If the first three conditions occur, then politicians should stimulate and support these systems, creating good conditions for their food production and promote the consumption, of products from these systems, towards the population.

We believe the two elements are essential to change the desertification tendency, working on a national level. The first is a mentality change. Environmental protection cannot be seen as a fight between two opponents, the producer and the ecologist. On the contrary the introduction of the *social optimum* concept is essential to identify what are the right solutions to be found for different areas. And these right solutions are the second key element. It is essential to identify which are the *Sustainable Agro/Forestry Systems* adequate for each region. Only systems that will lead to economic development enough to bring more people into the region, but not diminishing the potential use of lands, can be a part of the solution. These cannot be centralized solutions but well based on local people. On this line of thought is interesting the quote from Pereira: "*The largest effort must probably be placed on education, not only the children and youth, but the society and those responsible for decision-making at all levels*" (PEREIRA *et*

*al*., 2006). The Portuguese case presents one very interesting case of one of these SAS. The traditionally managed *Montado* (cork oak and holm oak forests) ecosystem is a good example of sustainable use of land in Mediterranean area. Multifunctional uses like agro-tourism, medicinal and aromatic plants production, mushrooms or game hunting can origin important economic revenues and revitalize these degraded areas.

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