

Desertification in the Mediterranean Europe. A case in Greece

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ABSTRACT

Desertification, as defined by the 1994 Convention of the United Nations, has affected large areas in the European Mediterranean and is threatening even larger territories. The vulnerability of the land to severe degradation that leads to desertification is attributed to several factors, including: large moisture deficits, climatic variability with frequent extreme events, steep terrain, geologic formations favouring desertification processes, out of phase climatic and vegetative periods, shallow soils and long periods of intensive human interference. Under the existing natural conditions lands have inertia and resilience, and resist extreme degradation. Desertification processes have been triggered and accelerated only by human action.

Process of desertification are either physical or chemical. The dominant physical process is soil erosion, which is activated by the destruction of the vegetative cover and affects marginal sloping lands. Soil salinization and natrification is the dominant chemical process. It is localized but affects valuable low lands and is the result of irrational irrigation practices.

In this paper, we present an example of range land desertification in the island of Lesbos in the North-eastern Aegean Sea. Three distinct climatic zones exist in the 167,000 hectares island: semi-arid, subhumid and a transitional zone. Desertification has affected continuous territories in the semi-arid zone and shows a fragmental pattern in the transitional zone. Sequential land use changes that lead to acute soil degradation were: destruction of the original oak forest, cultivation of rain-fed cereals grazing, land abandonment, dominance of unpalatable thorny small plants (economic desertification), burning of thorny vegetation followed by overgrazing resulting in irreversible physical desertification. Interactions among climate, geology, physiography, soils, vegetation and animals are discussed.

Key words: desertification, grazing, land abandonment, Lesbos, Mediterranean, soil erosion.

INTRODUCTION

Desertification, or “land degradation in arid, semi-arid and dry subhumid areas, resulting from climatic variations and human activities” (UN-CCD 1994) has been known to the people of the Mediterranean Europe and has been of concern since ancient times. Writers such as Solon, Plato, Theophrastus, Cicero, Pliny and Lucretius described land degradation and were aware of its consequences, but the degree of awareness has been uneven through the historical periods (Rubio 1995).

The phenomenon must be distinguished from the classical concept of desert as e.g. in Sahara Kalahari, where the aridity of the climate is a single and sufficient factor to cause desert like conditions regardless of the state of other environmental factors.

In Mediterranean Europe, desertification processes are activated and accelerated only when, in addition to climatic limitations, other land parameters are driven beyond critical thresholds by human action (e.g. Archer and Stokes 2000). Therefore, the phenomenon is spatially and temporally discontinuous.

VULNERABILITY OF THE LAND

Irrational human action can easily trigger desertification in the semi-arid and in the dry subhumid zones of Mediterranean Europe, because several land parameters are unfavourable and/or sensitive to such an action.

- Climate and bioclimate is characterised by large moisture deficits, temporal variability and frequent extreme events.
- Landscapes are rugged, with steep slopes, large elevation differences and are highly dissected by torrential streams.
- Surface geology favours formation of soils which are sensitive to drought and erosion.
- Hydrology is characterised by the scarcity of surface and ground waters, and by the need to bring water from elsewhere to satisfy demand.
- Soil formation rates are much slower than soil loss, resulting in inadequate rootable depth and water storage capacity on sloping land.
- Out of phase rainfall and vegetative periods.
- Four millenniums of human land use and frequent abuses of land.

PHYSICAL DESERTIFICATION

Desertification can be characterised as physical or chemical depending on the processes involved. Physical degradation occurs on sloping land and is very extensive. The dominant physical process is accelerated soil erosion which occurs on marginal lands which have lost more than 60% of vegetative cover (Thornes 1988) and their are located within the semi-arid and dry-subhumid zones. Accelerated erosion may lead to reversible or irreversible desertification.

Desertification is reversible when, soil moisture has been depleted beyond the tolerance level of the economically and environmentally valuable plants, but the rootable soil depth has not been decreased below critical thresholds. Main processes responsible for this type of desertification are soil erosion and surface structure deterioration. Both result in low rates of water infiltration and high rates of surface run-off and hinder seed germination. Reversible desertification can also occur when overgrazing has caused the occupation of the land by plants of low economical and environmental value. Hilly lands on marl and on Leptosols (shallow soils) are very sensitive to this type of desertification, but human action can mitigate them. Extensive areas in Spain have suffered this type of desertification.

Irreversible desertification is the terminal stage of accelerated erosion that has permanently reduced the rootable space and the water storage capacity of the soil below the tolerance levels of economically and environmentally valuable plants. Lands with Lithosols (very shallow soils) on limestone and southern slopes are the most vulnerable throughout the Mediterranean Europe.

The extent of physical desertification is not easy to determine accurately, because dependable indices are still being developed. An approximate estimate can be made on the basis of the CORINE (1992) soil erosion risk map (Figure 1). Many areas of high potential risk are vulnerable to desertification. Seriously threatened lands by water erosion cover about 50% of the EU Mediterranean. However, not all these lands are located in the semi-arid and dry-subhumid zones.

Using rootable depth and climatic aridity, it is possible to approximately estimate on a soil Map of Europe (Commission of European Communities 1985) the areas threatened by desertification as in Figure 2 (Yassoglou 1998).

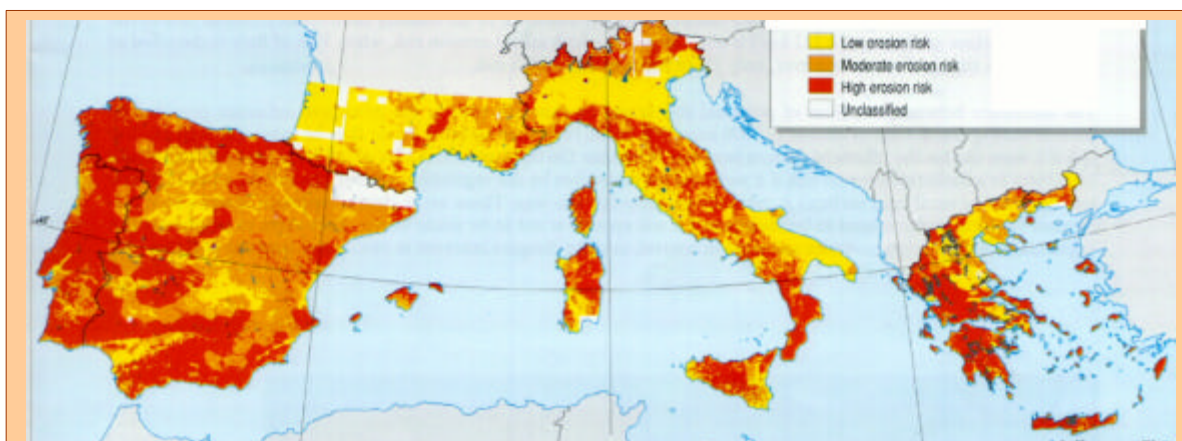


Figure 1. Map of potential soil erosion risk in the EU Mediterranean (CORINE 1992).

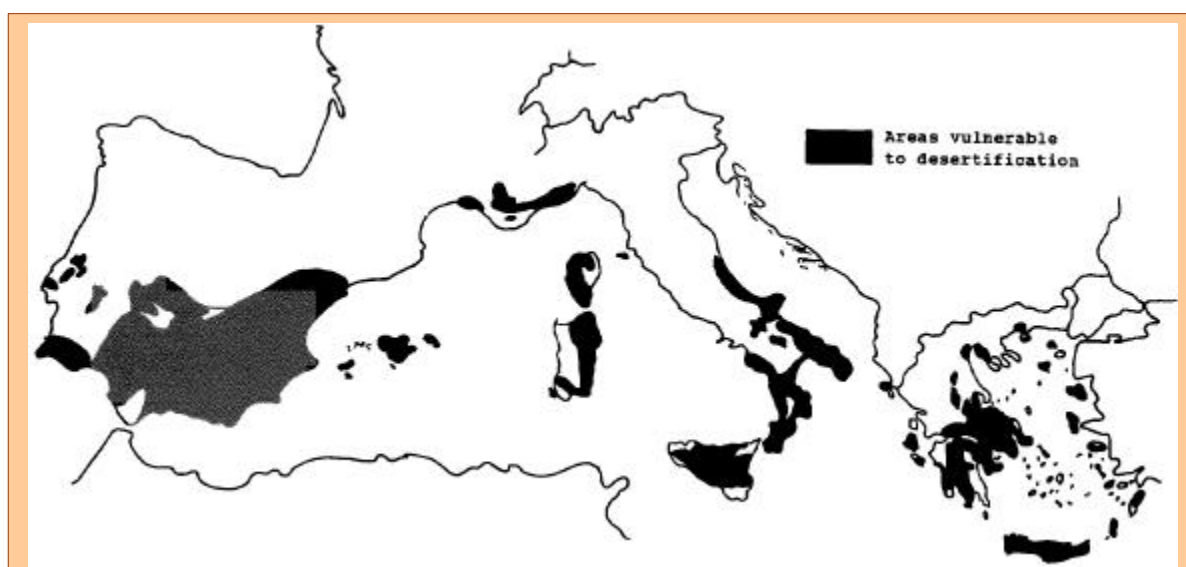


Figure 2. Soils sensitive to desertification in the EU Mediterranean (Yassoglou 1998).

CHEMICAL DESERTIFICATION

The dominant process of chemical desertification is secondary salinization of soils through irrational water management in irrigated lands. The main causes are:

- Irrigation with waters containing soluble salts exceeding critical thresholds.
- Irrigation schemes failing to meet leaching requirement or raising saline ground water tables.
- Over-pumping of coastal aquifers causing the intrusion of sea water.

Chemical desertification is localised in some alluvial plains and it is not very extensive in the Mediterranean Europe, however it affects valuable land.

LAND USE TRENDS AND DESERTIFICATION

There is a distinct trend of abandonment of rainfed agriculture in the marginal lands throughout the Mediterranean Basin and a shift of population toward more productive

lands or urban areas (Perez-Trejo 1992). This trend is locally reversed by subsidies provided by the European Union's Common Agricultural Policy (CAP).

Land abandonment is followed by two trends with opposite effects:

- Natural reforestation and expansion of forest and shrubs. These process drives the ecosystem towards recovery.
- Expansion of overgrazing encouraged by CAP subsidies drives, the system to acute degradation and desertification. Both cattle and small animals numbers have increased substantially during the last decades.

Intensification of irrigation has increased water consumption in many areas beyond aquifer recharge rates. This situation subjects the lowlands to chemical degradation and ground water depletion. Finally, sharp increases in tourist population constitutes a tremendous increase of human pressure on environmentally sensitive areas (ESA).

RESEARCH ACTIVITIES

For over a decade, the European Commission has recognised desertification as a major problem in the Mediterranean Europe and has supported research on its causes, impacts, spatial extend and mitigation. Multinational and multiphase integrated projects have been and are being conducted. These include MEDALUS I, II and III (Brandt and Thornes 1995), EFEDA (Bolle 1993), DEMON (Lacaze et al. 1995), and ARCAHEOMEDES (van der Leeuw 1995). Conferences were organised where the results were presented. A brief account of the scientific advances made so far is given below:

- General circulation models applied in the area show global warming will cause increase in temperature and decrease in rainfall.
- Satellite spectral data integrated with digitised geographic information systems can be used to fill some of the gaps in existing knowledge.
- Dynamic, physically based, multimodular integrated models have been developed and tested in the field. They can be used to delineate desertification environmentally sensitive areas (DESA) and to design mitigation schemes, where ever accurate and adequate data are available.
- Historical patterns of population and land use trends have been examined in some areas.
- Salt water intrusion in coastal areas and remedial practices have been tested in the field.
- More data are required for the accurate evaluation of the desertification risk and for combating it.

The International Conference on Mediterranean Desertification, held in Crete in October 1996 has concluded that:

- Desertification in the Mediterranean Europe deserves special attention by the people, the local, regional and the international authorities.
- Significant knowledge has been accumulated, but there gaps in indices, scaling the phenomenon and regionalization of model applications. Most serious gaps exist in socio-economic issues.

- There is need for international networks for research, monitoring, early warning and mitigation.
- International, regional and local cooperation for bottom-up mitigation practice is need. The active participation of the people affected is necessary.

THE LESVOS CASE

An example of desertification in the Mediterranean Europe could be the land degradation in the Greek island of Lesbos. The island is located at the eastern border of Europe, across Asia Minor. Its total area is about 161.000 hectares and it has been under effective human influence for about 3500 years.

Three distinct climatic zones: semi-arid, transitional and subhumid exist in the island. Desertification is widespread in the semi-arid zone, located in the west part of the island, and fragmented in the transitional zone located in central part of the island (Kosmas et al. 1996).

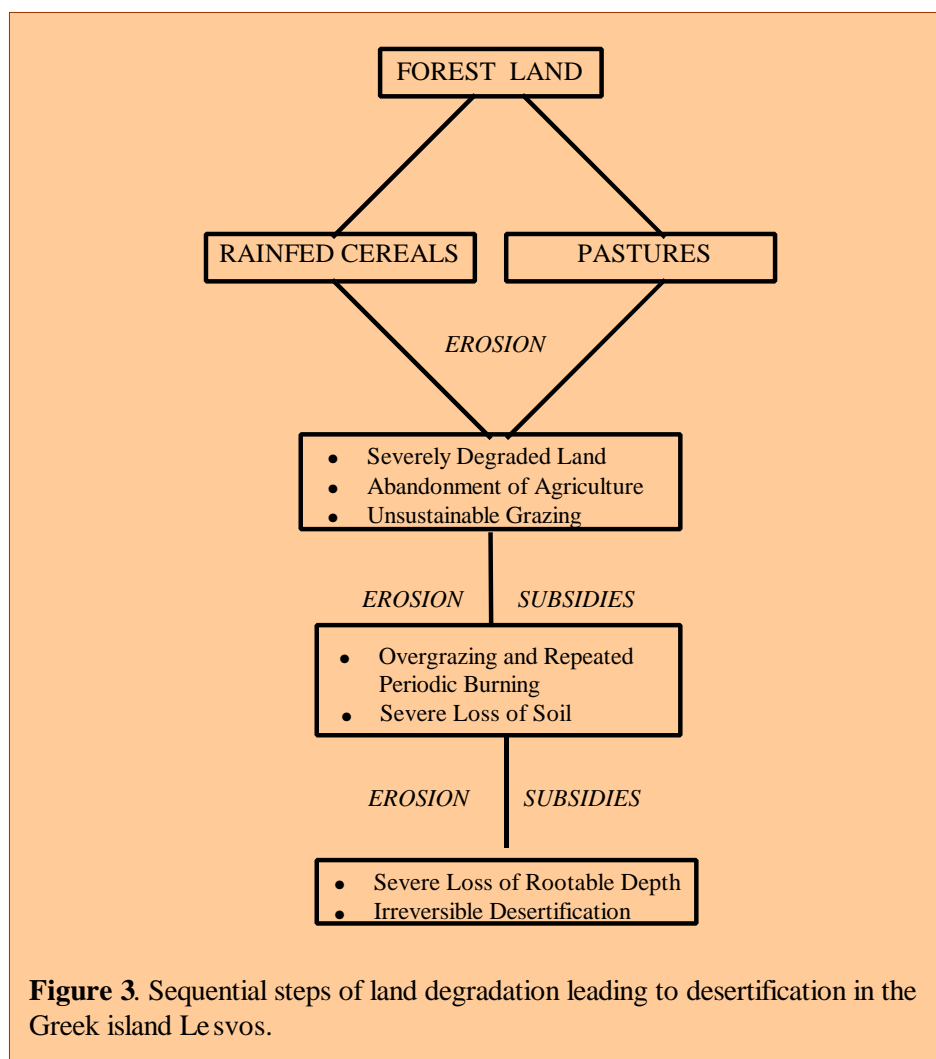
The dominant process of soil degradation is erosion following the thinning of the vegetative cover by human action. The sequence of events directly or indirectly related to human action and lead to the desertification of the land, in the semi-arid and transitional zones, are as follows:

- Destruction of the forest around 4000 years BP.
- Soil degradation due to soil erosion in the cultivated and grazed sloping land.
- Severe drop of land's productivity leading to abandonment of agriculture (around 500 to 40 years BP).
- Grazing of the abandoned lands further degrades the land.
- Occupation of pasture by non palatable plants mainly phrygane dominated by thorny *Sarcopoterium spinosum* L. arrest soil erosion, but contribute to economical desertification.
- Sharp increase of overgrazing accompanied by periodic burning of soil protecting *Sarcopoterium spinosum* (since 1955 AD).
- Very severe erosion and irreversible desertification (present).

Grazing animals act upon the soil accelerating erosion in a multiple ways, such as:

- Thinning of the vegetative cover.
- Compacting the soil surface, thus, reducing infiltration and increasing runoff.
- Digging the wet, soft soil and creating micro-escarpments, which create water microturbulence and enhance the erosive power of the surface runoff.
- Translocating downslope the protective stony mulch on the soil surface, thus reducing its resistance to erosion and the retainable soil moisture.

The sequence of land degradation steps are summarized in Figure 3.



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