B4 -LAND ABANDONMENT – Kostas Cosmas

Description of the reasons for land abandonment (Themes/processes/definitions)

The particular nature of the typical Mediterranean relief, with slopes subjected to extensive deforestation and intensive cultivation since ancient times, has led to soil erosion and the formation of shallow skeletal soils. As the soil is eroded, land use is usually shifted from agriculture to pasture due to increasingly poor yields from the various agricultural crops. Such a pasture land in the Mediterranean region is defined as an abandoned land today (Figure 1). Various authors have simultaneously used the terms 'abandoned land' and 'grazing land', but grazing or hunting of an abandoned land is considered as a traditional use in the Mediterranean region.

Figure 1. Land abandoned from agriculture in Lesvos (Greece, left) and Mertola (Portugal, right) used as pasture today

The importance of land abandonment from agriculture on desertification has been pointed out in the Article 2 of Annex IV of the United Nations Convention for Combating desertification. According to the Convention, each country of the Annex IV (including Mediterranean Europe countries) has to prepare and implement its National Action Plan and the corresponding Regional Action Plans for combating desertification. Except the other axes of policies and actions on combating desertification, the prevention of land abandonment through developing opportunities for alternative land uses is included.

The process of land abandonment can be affected by various factors related to physical environment, land management, and socio-economics characteristics of the area. Abandonment of agricultural land can be predicted by assessing various indicators related to land productivity and farmer's income (Figure 2) such as soil depth, parent material, slope gradient, amount and distribution of rainfall, existing subsidies, population migration, water availability, accessibility, etc. Several of these indicators are interrelated and depended on local conditions.

Soil erosion due to surface water runoff, winds and tillage operations is the most important process of soil loss in hilly areas affecting soil depth and water storage capacity, and consequently crop production and land abandonment. The Mediterranean must be considered as a region greatly affected by man-induced degradation over thousands of years. The evidence of degradation is very clear, with entire landscapes no longer being able to sustain any cultivation, while were previously covered with dense forests.

Accelerated soil erosion is as old as farming. Soil erosion was reported first by Homer in his Iliad. Greek hillsides were originally forested and covered by a fertile soil mantle,

which, however, was rather shallow and vulnerable to erosion. Upland grazing and farming probably began around the middle of the second millennium BC causing the initial damage of the forests. Several thousands of years of exploitive agriculture have greatly contributed to a dramatic reduction of agricultural productivity in the region, something which was already mentioned by Plato, who, speaking for Attica in the 4th century BC (Critias III), notes the occurrence of massive floods and landslides, of the disappearance of forests and the denudation of cattle pasture. Additional historical evidence relating to the effects of degradation on soil and vegetation can be traced to Roman times where land degradation resulted in the creation of large pastoral estates. Everywhere Romans established their dominion, repeating the same pattern of extensive forest clearing, over-cultivation and over-grazing of land to satisfy their food demands.

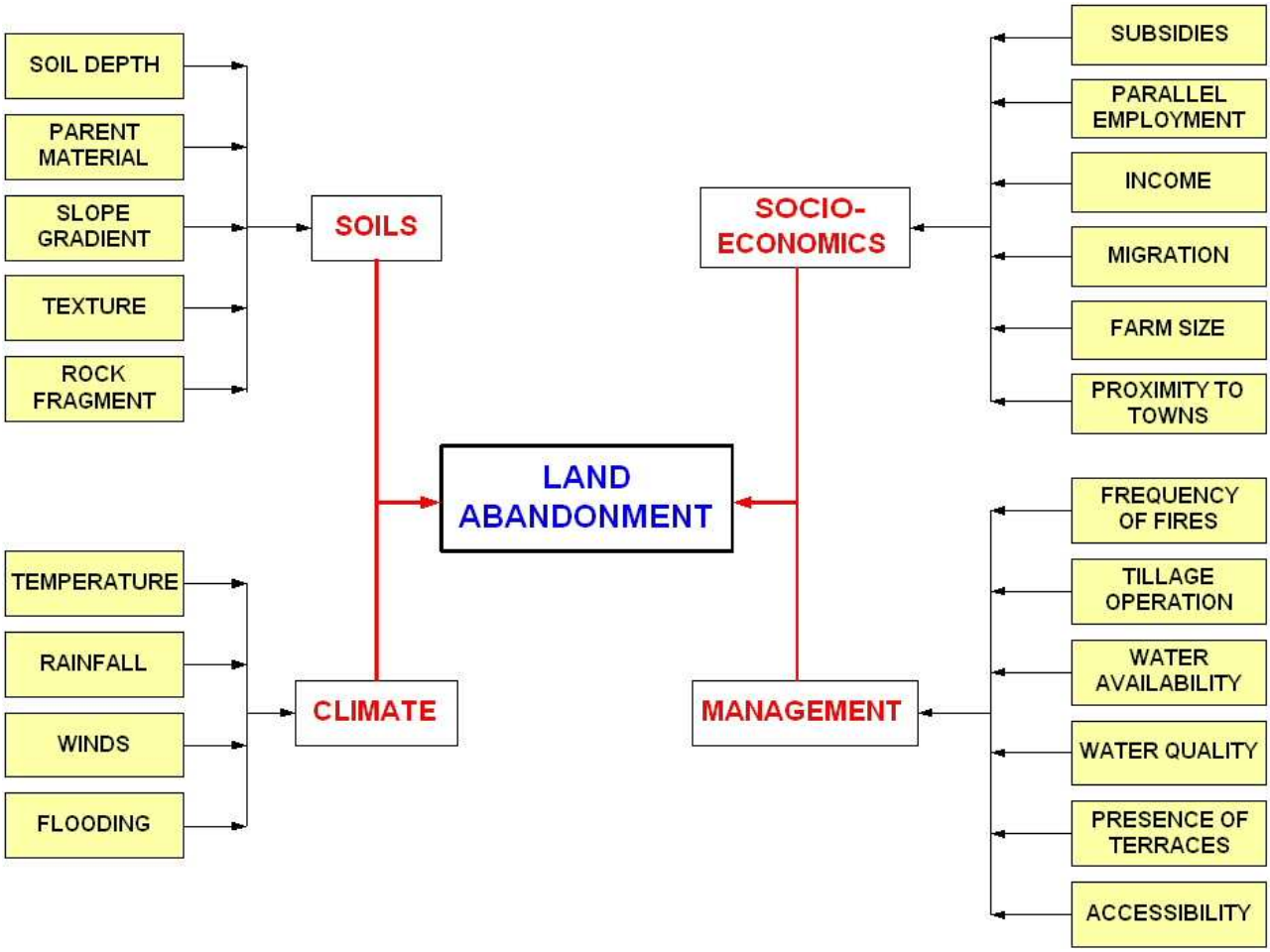

Figure 2. List of indicators related to land abandonment in the Mediterranean region

The analysis of land use evolution in the island of Lesvos for the last 4000 years showed a dramatic increase in agricultural land by replacing forested land. Many of the areas that once supported forests were cleared in order to sustain agriculture, but since measures of soil conservation were insufficient, these areas were severely eroded and abandoned from agriculture. Overgrazing and fires further destroyed the natural vegetation cover and prevented its regeneration. Now these areas are mainly unproductive, sparsely populated and desertified. The socio-economic and political background determined human impact on the environment and it was increasingly negative stimulating desertification. About 45-50 years ago extensive cultivated areas with cereals, vines and olives have been abandoned due to the

low productivity. After the abandonment, the area was moderately grazed and the growing shrubs were occasionally cleared by setting fires.

Soil erosion measurements, caused by surface water runoff, conducted along the Mediterranean Europe by the EU research projects MEDALUS I and II in a variety of topographic and soil characteristics and in a number of representative land uses such as olives, vines, cereals, eucalyptus and shrubs have demonstrated the great importance of total rainfall as well as land use on runoff generation and sediment loss, and therefore soil erosion. The following land use types can be graded in order of decreasing effect on soil erosion as following: vines> eucalyptus> wheat> shrubland> olives with an average soil loss ranging from 142,8, tones/hectare/year (vines) to 0,8 tones/hectare/year (olives) (Figure 3). Therefore vineyards can be considered as the land use causing the highest erosion rates in hilly areas under the existing land management practices in Mediterranean Europe promoting land degradation and abandonment.

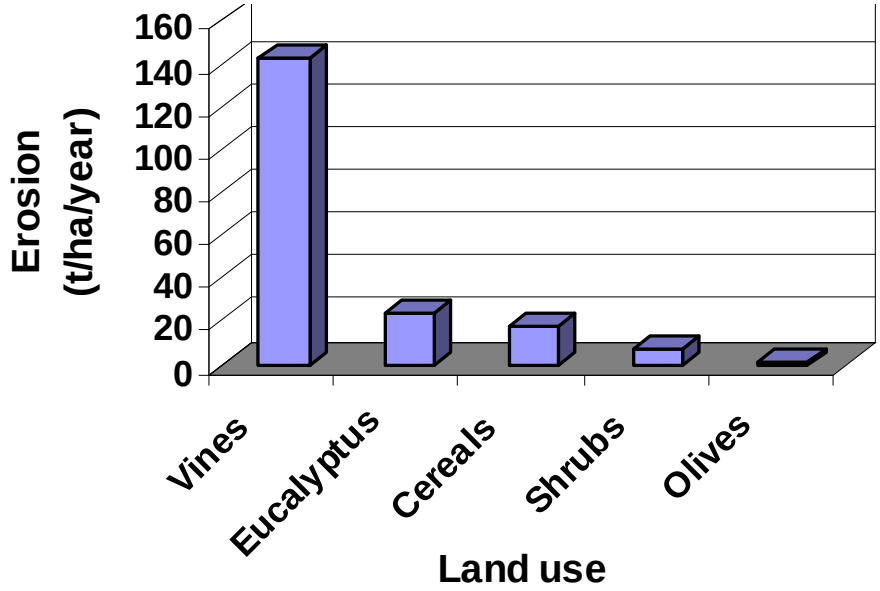

Figure 3. Average soil erosion rates measured in various soil, and topographic conditions along the Mediterranean Europe and in representative land uses

Tillage erosion is a progressive down slope translocation of soil caused mechanically by tillage implements, and it is considered as a main cause of land degradation and land abandonment in hilly cultivated areas in the Mediterranean. Areas which have been introduced to cultivation during this century are being abandoned at an increasing rate in the last decades due to dramatic decrease of the land productivity. Availability of heavy powerful machinery favored deep soil ploughing at high speeds in directions usually perpendicular to the contour lines. This resulted in the displacement of huge amounts of soil materials from the upper convex parts (summit, shoulder, backslope) of a hillslope to the concave parts (footslope, toeslope) and decreased significantly the production of the various crops on the convex positions, especially on soils with subsurface limiting layers such as petrocalcic horizons or bedrock (Figure 4). Long term studies conducted in hilly cultivated areas of Thessaly (central Greece) have clearly shown that tillage rather than water erosion is the most important factor controlling land degradation. Water erosion in areas cultivated with cereals, vines or olives is responsible for a loss of a few millimetres (1-3) of soil per year or even less. The estimated total annual loss of soil in the same areas cultivated mainly with cereals is 12-16 mm per year. It is estimated that 8% of the hilly agricultural land in Greece should have

been abandoned in the last decades due to the low land productivity caused by erosion but this land remain in agriculture due to the existing subsidies.

Semi-arid landscapes by definition are water-limited and therefore are potentially sensitive to environmental change and to plant growth. The water available for rainfed plants to grow depends on the climatic conditions (rainfall, evapotranspiration) and the soil water storage capacity. The water storage capacity of a soil is defined by the water holding capacity of each soil layer and it is related to soil texture, soil depth, amount of rock fragments, parent material, etc. Crop production in hilly Mediterranean areas is largely related to soil depth. Hilly soils formed on consolidated parent materials such as limestone, sandstone, volcanic lava, etc. usually have a restricted effective rooting depth as the soils are eroded and shallow. Soil depth defines the root space and the volume of soil from where the plants fulfil their water and nutrient demands. Under dry climatic conditions, which generally prevail in such areas, production of rainfed crops rapidly declines, cultivation is no longer profitable in soil depths usually less than 30 cm leading to land abandonment.

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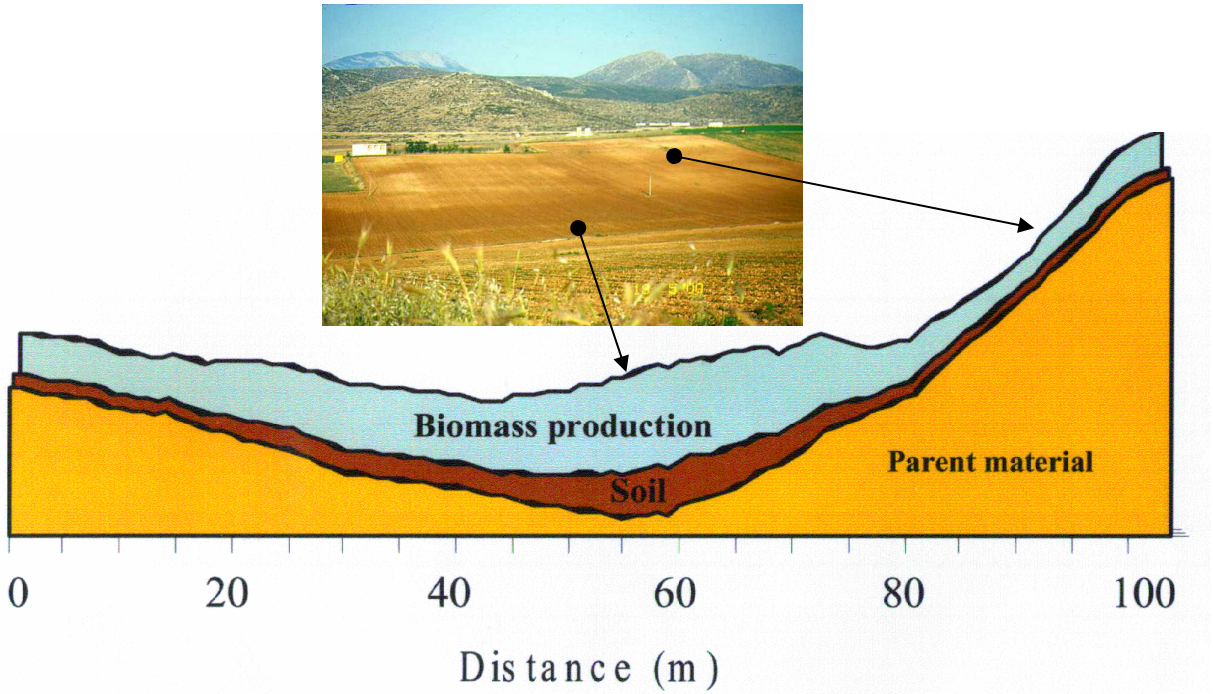

Figure 4. Changes in soil depth and wheat biomass production along a catena undergoing high tillage erosion

The amount of agricultural products have affected land abandonment. In the early years of the European Common Market it became clear that the reduction of the farmland area was not adequate to compensate the increase in the produced agricultural products. Therefore, the Mansholt Plan (in 1968) was proposed to encourage the abandonment of a further five million hectares, mainly in southern France ,the Massif Central, Corsica and southern Italy, but this action was proved as very drastic. More recently, land in south Europe has been temporarily left uncultivated under the conditions of set-aside subsidies. This measure, however, do not identify land that ought not to be cultivated.

Drivers, causes and extent of the problem of land abandonment

Land use changes in the Mediterranean during recent history are mainly due to physical and technical factors as well as socio-economic reasons. Particular land uses have been related to specific population behaviours, spatial distribution changes, and pressure over natural resources. The region has suffered important transformations since the middle of the nineteenth century, when the agricultural development really began. Land mismanagement stimulated by demographic dynamics resulted in shifting of the agricultural population (and activities) to marginal areas unsuitable for agriculture. Human impact on the landscape was increasingly negative through conventional large-scale extensive agriculture, negatively affecting soil properties and enhancing the erosion processes. The extension of cultivated areas at the expense of forest land implies high ecological alterations due to deforestation and the break-up of the original equilibrium between cultivation, grazing and forestry.

Short-term capital investment and intensive cultivation have often resulted in land degradation. **Land profits are usually not invested for land conservation measures, but are simply reinvested for cultivating another area.** The most significant change in the current land-use distribution in Mediterranean Europe is the increasing intensification of agricultural land in terms of mechanisation, extensive use of agro-chemicals, and irrigation.

The Guadalentín basin in south-eastern Spain may serve as an example for demonstrating the impacts of land transformation changes and population evolution on land degradation. The basin is characterised by the greatest hydrological deficit in the Iberian Peninsula and also in Europe. The Guadalentín has suffered significant transformation since the latter half of the 19th century, when agricultural development began. Since then agricultural activities and some mining have seriously affected the rural landscape and the whole environment in general. In the hilly Guadalentín basin man-induced land degradation has been particularly high due to intensive cereal cropping, grazing and exploitation of *Quercus* forest resources (Figure 5). Inappropriate agricultural practice and management in relation to soil properties, topography, and climate has stimulated by economically based political decisions that has resulted in expansion of agricultural land to marginal areas with poor soils**.** Another negative human impact on the landscape has been through conventional large-scale extensive agriculture using mechanisation, weakening soil properties in relation to weathering and erosive processes. Due to economic reasons and also as a response to soil degradation, large areas then had to be abandoned or used only for grazing.

Figure 5. Hilly degraded areas in Guadalentin Basin, Spain, (left) and Agri Basin Italy (right) in which the natural vegetation was replaced by agricultural crops

In the last four decades, favourable soil and climatic conditions and the availability of ground or surface water has resulted in intensive farming of the lowlands of Mediterranean.

The development of high input agriculture in the plains provided much higher net outputs than those obtained from hilly areas or terracing agriculture. Furthermore, the development of fast transportation means and the availability of cheap holiday-offers have encouraged the expansion of domestic and international mass tourism over the last 30 years. The rapid expansion of tourism in the Mediterranean Europe along the coastline resulted in the last decades in intensification of agriculture on the low lands, abandonment of agricultural terraced land on the slopes, and increase in the number and frequency of fires. The high demands for water consumption or other economic activities have increased the price of water and forcing the cost of agricultural production to increase, while in many cases, water of low quality (high electrical conductivity) is used for irrigation. Irrigation using water with high salt concentrations increased the salinity of the soil, rendering an unproductive abandoned and desertified land especially plain areas located along the coast.

Case examples of land abandonment

The Lower Inner Alentejo, Portugal - left bank of the Guadiana river

This area is located in the South-Alentejo peneplain (south east of Lisbon). The landscape is characterized by flattened summits and gentle slopes, and simple slope profiles not exceeding 25 %. However, there are in some places steep slope angle sectors, due to lithology contrasts (bedrock outcrops) and where streams are deeply incised along the Guadiana river. The soils are characterized as Mediterranean red soils, shallow 10 to 30cm, or very shallow, less than 5cm deep. The climate is Mediterranean, continentally enhanced, rainfall being concentrated in the autumn and winter (67 % of the total annual rainfall on average), followed by a long hot and dry season from May to September. Rainfall variability is extreme, annually (ranging from 1041.4 mm in 1989/90, to 236.4 mm in 1980/81) and monthly (total annual average, for the 1931/90 period was 562 mm), and sometimes concentrated in a few, very violent, events with thunderstorms.

The analysis of land use evolution in the lower inner Alentejo over the last 300 years showed a dramatic increase in agricultural land by replacing forest and shrubland. In the beginning of the 19th century agriculture was already widespread, with cereal cropping and grazing. The intensity of man-induced environmental degradation, especially on areas that were not suitable for uses either than low density grazing, started back in the Middle Ages.

Between 1900 and 1950, almost all the remaining areas with natural vegetation (hill tops, steepest slopes) were transformed into cereal fields, as colonization was encouraged by communal land division and donation. Most of the Inner Lower Alentejo became a treeless area of cereal monoculture, with some patches of *Quercus* (oak) and shrubland. This was further stimulated by a governmental policy called the Wheat Campaign, that supported farmers (with seed, fertiliser, machinery and subsidies). By the 1950s there was an official realisation that soil degradation had reached serious proportions.

Between 1950 and 1985 agriculture started to decline, people started emigrating to the main cities and abroad, and depopulation began. Land abandonment became a reality. After Portugal joined the EU in 1986, wheat production costs were 3 to 4 times higher than elsewhere in northern Europe. Currently the tendency is towards land-abandonment or to a conversion of agricultural land, through reforestation with endogenous species (*Quercus suber*, *Quercus ilex*), or in most cases pine trees (*Pinus pinea*). There is, however very recently a new interest in cattle, cows mostly, in addition to sheep already there for a long time, which has been further supported by the CAP subsidies. In this way vast areas that had been abandoned are being reconverted into pastures, both natural and improved (Figure 6). However, this process has critical implementation phases, as the soil is subject to practices

favouring the degradation of their physical and chemical proprieties, such as when shrubs are cut and destroyed, or when ploughing to prepare the pastures for seeding is carried out too deeply. **Nonetheless, according to the edapho-climatic characteristics of the Lower Inner Alentejo, land abandonment allows an improvement of soil conditions, and favours the appearance of natural vegetation species (annuals and perennials), that minimize and tend to almost neutralize the soil erosion processes.**

Figure 6. Abandoned land used as pasture today (left) and reforested after abandoned (right) in Alentejo, Portugal

Soil erosion measurements obtained, surveying 20 x 20 metres plots in abandoned areas of different ages (between less than 5 years and more than 25 years), carried out within the framework of the MEDALUS II Project, revealed (in terms of soil properties) a clear recovery in organic matter content and drainage conditions, as well as a better development of the soil vertical profile. The vegetation cover became more dense, with an increasing number of species, the longer the time since abandonment.

Guadalentin Basin, Spain

The Guadalentin Basin is characterized by similar soil, climate and land management conditions as those in Alentejo region. In the Guadalentín basin in southeast Spain, the main factors leading to land abandonment, especially in dry farming areas, are socio-economical. The land abandonment processes are most likely to happen in dry farming areas because irrigation activities, which require smaller land area and yield high profits, are less likely to be abandoned.

In general, dry farming is becoming increasingly marginal. EU subsidies are necessary to assure sufficient farm income, so changes in EU regulations affect farming decisions. The farmer's age is another important factor. New generations are reluctant to carry on the activity as incomes are not assured and they prefer to work in other economic sectors, often out of the rural areas. Fragmentation of land parcels is also important. Larger areas are needed for a dry farming parcel to be profitable but land partition processes (from fathers to sons) makes it more difficult.

In the specific case of the Guadalentín area in Murcia, parcels of land under almonds are the most likely to be abandoned. This is the most important cultivation in dry farming areas, commonly in stepped areas or marginal soils. Some of the areas have changed to olive cultivation because more EU subsidies are available for olives. Low profitability due to low

market prices, climatic events such as drought and frost, competition from markets in other countries all lead to land abandonment.

Figure 7. abandoned terraced land in Guadalentin Basin (left) and in Almeria (right), Spain

Agri Basin, Italy

The Agri Basin is located in the Basilicata region, southern Italy. It is situated in the middle of the Basilicata Apennine Mountains and covers 1,730 square kilometres, with a population of 94,291 inhabitants. Major changes in the landscape took place during the last century (Morano, 1994, Storia di una società rurale: la Basilicata nell'ottocento, Laterza, Bari), when massive deforestation took place (Tichy, 1962). In comparison to the available 290,000 ha of forest cover for the whole of Basilicata at the beginning of the last century, it is estimated that 17% was destroyed from 1800 to 1860, 20% from 1860 to 1908, and 19% from 1908 to 1930. Despite measures adopted by the French and then the Bourbonic authorities, more than half of the forest cover of Basilicata was destroyed during this period. This was principally due to population growth, but also to major social transformations during the last century. However, at the same time a "wheat battle" was engaged in to counterbalance the prohibition of emigration and supply the growing needs of the population, resulting in expansion of the cultivated area and reduction in the impact of soil conservation measures.

In the last decade the Agri Basin has suffered a strong contraction in the values of the Total Agricultural Area (TAA) and also in those of the Utilised Agricultural Area (UAA). Such reduction in agricultural area affects the types and distribution of crops. Considering the type of cultivations that requires more consistent intervention both in intensity and frequency of action (i.e. sown and arboreal crops) and looking at changes in this value within the total surface, it can be seen that in the whole Agri Basin, there is a progressive decrease in the degree of agricultural use of the territory (Figure 8).

A comparison between this information and the trends also in sown and arboreal crops in relation to Utilised Agricultural Area allows a clearer interpretation of what has happened in the different sections of the basin. In the Lower Agri Basin, although there has been a contraction of about 10% in agricultural land use, there has been an intensification in the primary sector. 91% of the UAA is in intensive crops. In reality there is strong competition for the use of soil resources between the agricultural sector and the other economic sectors, especially tourism, and this explains the progressive reduction in areas sown. In the Middle Agri Basin both the values show negative signs underlining extensive agricultural activity and progressive abandonment of the land. For the Upper Agri Basin there is similar behaviour, although less marked in comparison to the Lower Agri Basin.

The island of Lesvos, Greece

The Greek island of Lesvos is located in the north-east part of the Aegean sea covering an area of 163,429 hectares. It is characterized by a variety of landscapes, lithological units and climatic conditions. The land is covered by a number of land-uses representative of the Mediterranean region e.g. semi-natural forests and shrubland, and agricultural land that is now largely being abandoned. The climate of the area is characterized by strong seasonal and spatial variations of rainfall, and large oscillations between minimum and maximum daily temperatures, typical of Mediterranean climatic conditions. A gradient in rainfall occurs across the island with the average annual rainfall in the study sites ranging from 677 mm (eastern part) to 415 mm (western part). The greater part is already badly degraded and desertified, and the rest is experiencing a slow but constant deterioration of its natural resources.

Figure 8. Land highly degraded and abandoned in the Upper (left) and Middle (right) Agri Basin, Italy

The analysis of land use evolution on Lesvos over the last 4000 years has showed a dramatic increase in agricultural land replacing forested land. Many of the areas, in the dryer western section, that once supported forests were cleared in order to sustain agriculture, but since measures for soil conservation were insufficient these areas were severely eroded and consequently abandoned. Overgrazing and fires further destroyed the natural vegetation cover and prevented its regeneration. Now these areas are mainly unproductive, sparsely populated and desertified. The socio-economic and political background determined human impact on the environment and it was increasingly negative, stimulating desertification. About 45-50 years ago areas extensively cultivated with cereals, vines and olives were abandoned due to low productivity. After the abandonment, the area was moderately grazed and the growing shrubs were occasionally cleared by setting fires (Figure 9).

An analysis of the various micro- and macro-factors affecting land use change decision-making from agriculture to abandoned land followed by grazing in the island of Lesvos for the period 1965-2002 have shown that the most important factors were: family size, farm size, annual rainfall, policy enforcement, proximity to recreation areas, sensitivity to desertification, and presence of terraces, (Figure 10). Abandonment of the land may occur in areas experiencing adverse environmental conditions. Areas with lower annual rainfall and high sensitivity to desertification are more vulnerable to land use change from agriculture to pasture. In the same study was found that a piece of land remains in agriculture under certain

physical environment, socio-economic and land management characteristics. Conditions mostly favoring no land use change were deep soils, dry sub-humid climatic conditions (high annual rainfall), and lower land sensitivity to desertification.

Figure 9. Highly degraded and abandoned areas in Lesvos (Greece) after cultivation for a long period with rainfed crops and used as pasture today

Lessons learnt from land abandonment and future perspectives/recommendations

Land abandonment is a major issue of areas in which land degradation has proceeded in large extent. The abandonment of the land can have great impacts on the environment and the economy of local communities. The effects of land abandonment on the environment or more specific on land quality may be positive or negative depending on the soils and climatic conditions of the area. Soils under favourable climatic conditions that sustain plant cover may improve with time by accumulating organic materials, increasing floral and faunal activity, improving soil structure, increasing infiltration capacity, and therefore decrease erosion potential. Studies conducted in southern Spain have shown a positive effect of land abandonment after a period of over ten years in which characteristics of abandoned soils approached those seen before cultivation. The abandonment of this area resulted in improvement of soil characteristics such as the organic matter content, water retention capacity, aggregation and structural stability, and hydraulic conductivity.

Similar studies conducted in the island of Lesvos showed that the most significant soil improvement after a period of 40-45 years of abandonment was related to the increase in organic matter content and aggregate stability of the surface horizon (Figure 11). Soils formed on pyroclastics parent material have lower capacity to regenerate natural vegetation, and this leads to higher erosion rates. Soils formed on shale, ignimbrite, schist-marble, and volcanic lava have a higher capacity for at least partial regeneration of natural vegetation. The nature of the parent material becomes increasingly important in vegetation establishment and land protection as soil depth is reduced due to erosion. Under the soil and climatic conditions of the study area, a cultivated hilly landscape must be abandoned before the soil achieves the **critical depth of 25-30 cm.** The recovery of the natural vegetation is very low below this depth and the erosional processes may be very active resulting in further degradation and desertification of the land. If a soil obtain a depth lower than about 10 cm, depending on the parent material, then the perennial vegetation can not be supported and the whole soil is rapidly washed out by wind or water erosion. Degradation and desertification of this land is ultimately an irreversible process.

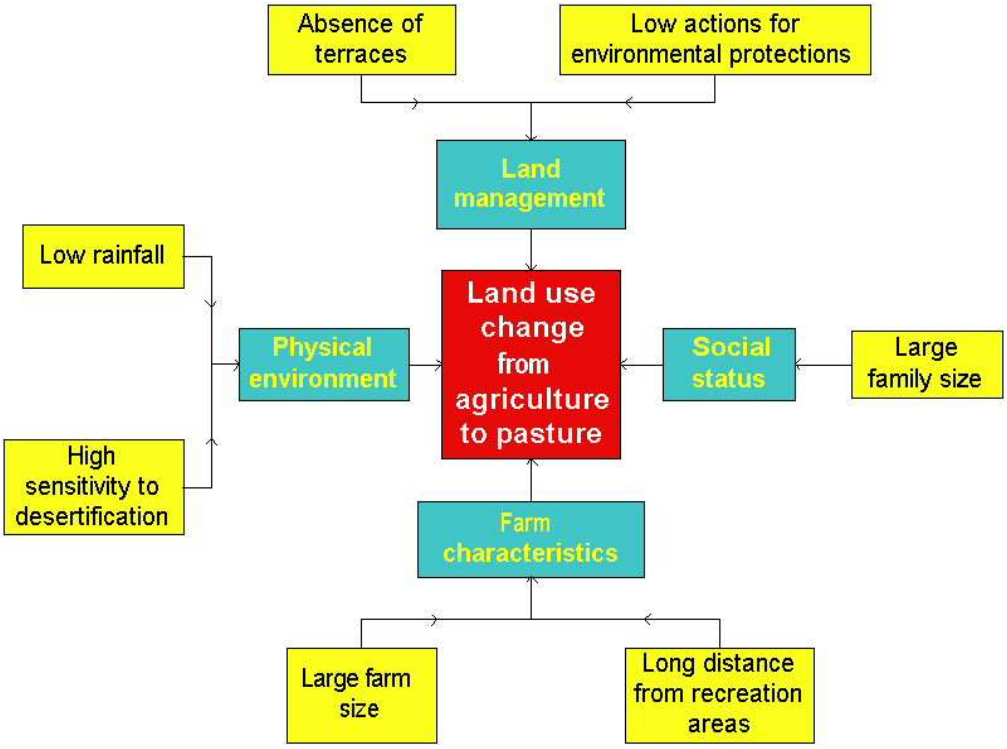

Figure 10. Important factors affecting land use change from agriculture to pasture in the island of Lesvos

Large areas of the Lower Inner Alentejo (Portugal) that had been abandoned are being reconverted in pastures, by allowing the land to remain under natural conditions or applying practices for improving it such as shrubs clearing, ploughing, sowing seeds, etc. However, this type of land management has critical implementation phases, as the soil is subject to practices favouring the degradation of their physical and chemical proprieties, like when shrubs are cut and destroyed, or when ploughing to prepare the pastures seeding is performed too deep. Nonetheless, according to the physical environmental characteristics of the Lower Inner Alentejo, land abandonment allows an improvement of soil conditions, and favours the appearance of natural vegetation species (annuals and perennials), that minimize and tend to almost neutralize soils erosion processes. The experimental results obtained during the execution carried out during the EU research project Medalus II have shown that after abandonment of the land organic matter content, drainage conditions, and better development of the soil profile. The vegetation cover became more dense with an increasing number of plant species as the period of land abandonment increased.

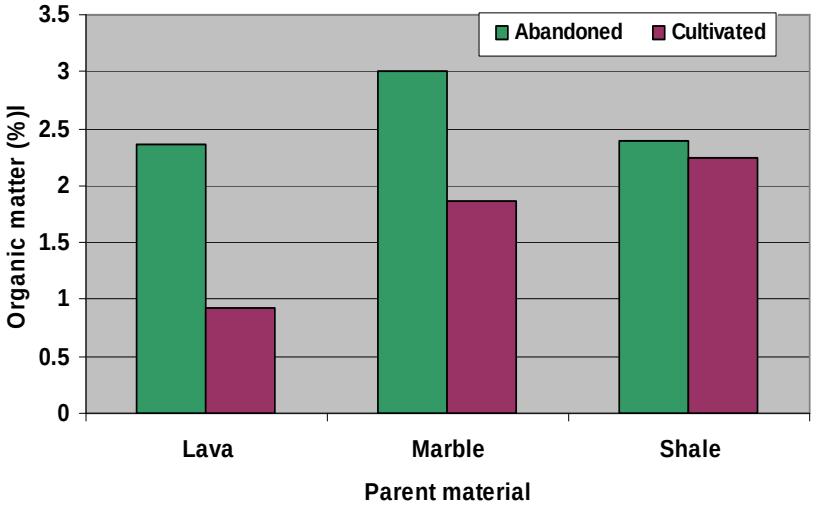

Figure 11. Changes in soil organic matter content in the surface horizon in abandoned and cultivated soils in the island of Lesvos

Vegetation cover becomes crucial for the protection of the land after abandonment. Where vegetation cover is sparse, erosional processes may be very active and the degeneration of the abandoned lands may be irreversible. Many authors have demonstrated that in a wide range of environments both runoff and sediment loss decrease exponentially as the percentage of vegetation cover increases. Studies conducted in the Spanish Pyrenees have shown that only 3.5 % of fields abandoned for a period of less than ten years did not suffer from erosion, and 60 % of the fields suffered severe sheet erosion without sufficient protection from a vegetation cover. Soil erosion studies conducted along the Mediterranean Europe on hilly shrublands have shown that runoff and sediment loss increased with decreasing annual rainfall (above a threshold of 280-300 mm), and attributed this to a decrease in vegetation cover. For areas with rainfall below this threshold, erosion decreased with increasing rainfall (Figure 12).

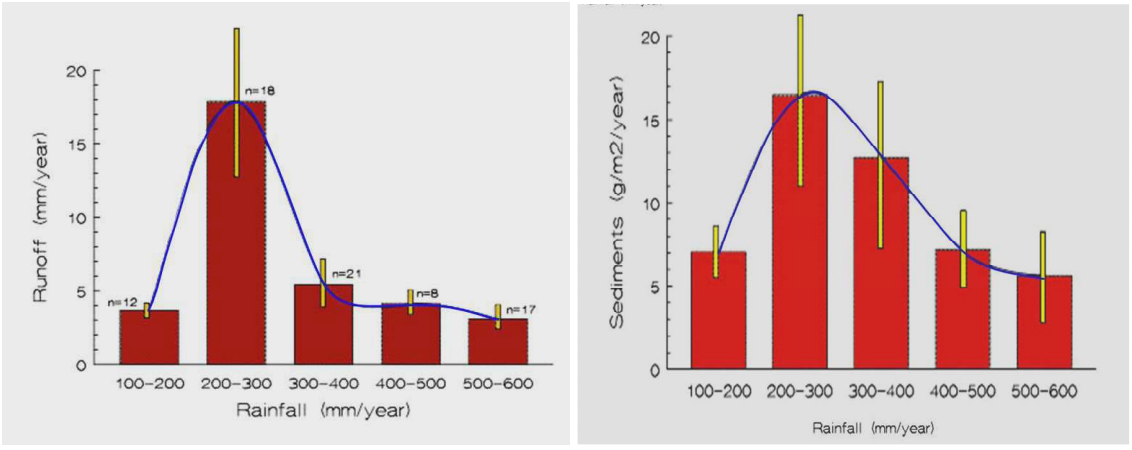

Figure 12. Annual water runoff and sediment loss measured in hilly areas covered with shrubs around the Mediterranean region

Moderate grazing pressure on abandoned agricultural land may lead to partial rejuvenation of vegetal communities with a high diversity index. The decline in vegetation by overgrazing can include the loss of particular herbaceous families (*Leguminosae, Gramineae*) which help to maintain soil structure. Plant species from these families can both protect the

soil surface from raindrop splashing and reduce erosion rates by increasing soil aggregate stability.

The process of land degradation can be greatly accelerated by high densities of livestock which lead to vegetation degradation and, in turn, to soil compaction (Figure 13). An obvious consequence of overgrazing is the increase in soil erosion, since the gradual denudation of the landscape exposes the soil to water and wind erosion. Overgrazing of climatically and topographically marginal areas, accompanying by fires, constitutes a desertification-promoting land use, further deteriorating the existing land resources.

Figure 13.Grazing land in the island of Lesvos (left) and in Beja (Portugal) with high density of animals favoring soil compaction and erosion

Disturbance by grazing does not result in the complete removal of vegetation as an intense fire does. The impact of fire is greatest in those areas with the lowest fire frequencies. An increase in fire frequency leads to fewer plant species, caused by the loss of those which cannot persist when fires are too frequent.

An integrated approach for protection of land abandonment requires to know not only the present characteristics of the area that is abandoned but also the history of land use (or land use evolution) in the area. These factors will give an idea about the processes that can occur after abandonment. In fact, the areas that are abandoned first are those less profitable or more difficult to be cultivated. Areas such as existing in the Guadalentin basin (Spain) are marginal with steep slopes, and abandonment has relevant consequences for several degradation processes. In these areas natural restoration is very difficult, and high aridity and soil water deficit make it even more difficult. The low organic matter content, low vegetation cover, steep slopes and adverse climatic conditions (less than 300 mm of rainfall/year, with torrential rain, drought events and strong insolation of nearly 3000 hours/year), result in a high moisture deficit and give an extremely arid character to the basin. These conditions make erosion processes common and intense. The natural restoration processes in these areas are really slow, almost impossible, and persistent erosion processes can lead to severe soil degradation and desertification.

Subsidies are allocated today in specific types of crops or land uses such as olives, cereals, pastures, etc., greatly affecting the intensity of the land use, the land use decision-making, and the income of the farmers. For example in some cases the productivity of hilly areas with shallow soils and semiarid climatic conditions cultivated with cereals is very low, not economical feasible without any support. In several cases such land must be abandoned

allowing the natural vegetation to be growing. Furthermore, in abandoned land used as pastures the number of animals has increased significantly in the last decades due to allocation of subsidies per animal. Subsidies in such cases have adversely affected land degradation and desertification of abandoned land.

In the frame of presently existing socioeconomic conditions In southern Europe, abandonment of marginal agricultural lands seems to be inevitable and in many cases beneficial to the preservation of land resources. The questions to be answered are when and where the abandonment should be followed by controlled grazing or left to processes of recovery of the forms of natural vegetation. Ecosystems that could be established on the abandoned agricultural lands of the Mediterranean Europe are the following:

1. Semiarid zone: In marginal areas with annual rainfall lower than 350 mm any form of pastoral exploitation would certainly lead to further land deterioration and desertification. On the other hand, if land is left alone and protected from grazing, a low grade of natural vegetation consisting of drought resistant plants could be established. This type of vegetation could support a wild life ecosystem, which sufficiently arrest further degradation and offer recreational and other environmental benefits, without substantial expenses. Other uses such residential and tourist uses could also be encouraged in suitable areas.

2. Dry- subhumid zone: In areas with annual rainfall exceeding 400 mm, controlled pastoral exploitation could be feasible in locations having soil depth greater than 30 cm, slopes lower than 25%, sufficient infrastructure, and favourable socioeconomic conditions. The thresholds of soil and land characteristics should be adjusted to the local conditions of parent materials, rainfall, aspect and land form. The type and the number of gazing animals should also be adjusted accordingly. It is important that the change of the abandoned agricultural lands to pasturelands follows a serious study of the above parameters, exact assessment of land capability, and socioeconomic feasibility. Furthermore an efficient control system should be established. Otherwise, a serious land and environmental deterioration would occur. The respective subsidies and other provisions of the Common Agricultural Policy of the EU should meet these requirements.

3. Subhumid and humid Zones: Other areas with annual rainfall exceeding 600 mm and having land, infrastructure, and socioeconomic parameters outside the thresholds set for pastureland should be left to processes of developing a climax natural ecosystem protected from illegal grazing at least during the first 5- 10 years. The speed of development and the quality of the ecosystems will depend on the values of parameters mentioned above. Experience in Greece shows that forest stands cover abandoned marginal agricultural lands rather quickly and efficiently.

Indicators related to the resilience of abandoned agricultural lands, that should be considered in assessing their capabilities and selecting their future use are similar with those leading to abandonment but required more refined assessment. Resilience indicators of land abandonment could be the following: land form, slope aspect, parent material, slope gradient, soil depth, annual rainfall, air temperature, floods, soil salinity, infrastructure, and socioeconomic conditions.

Further reading or information

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