BOOKLET C5

Mediterranean desertification landscapes: Grazing lands and pastoral landscapes

Vasilios P. Papanastasis

Laboratory of Rangeland Ecology, Aristotle University of Thessaloniki

541 24 Thessaloniki, Greece

TABLE OF CONTENTS

WHAT ARE GRAZING LANDS?

(P3)

Grazing lands are plant communities composed of herbaceous or woody or both groups of species that produce forage primarily used as feed by domestic animals. They may be cultivated, known as *agro-pastures*, or uncultivated, known as p*ermanent pastures* or *rangelands*. Agro-pastures may have some degradation problems, especially in areas where annual forage species are cultivated. This booklet, however, will mainly deal with the permanent pastures where serious degradation phenomena appear.

Permanent pastures occupy an important part of Greece, Italy, Portugal and Spain (see table). They represent marginal lands, mainly used as grazing lands by *sheep*, *goats* and *cattle*. The majority of them are found in dry, semi-dry and sub-humid areas. They are subdivided into grasslands, shrublands and open forests, also known as silvopastoral systems.

Grasslands are dominated by herbaceous species, particularly annual grasses and legumes, while a great variety of other species is also found. They grow in dry (pelouses) or wet (meadows) sites. They are the main grazing lands for sheep and cattle while goats can also use them.

Shrublands include dwarf shrublands, known as *phrygana* in Greece and *tomillares* in Spain, dominated by spiny or aromatic half-shrubs; open shrublands, known as *garrigues* or *garriga*, which are usually found on calcareous soils and dominated by evergreen or deciduous shrubs; and dense shrublands, also known as *maquis* or *matorral*, which are usually found on siliceous soils and dominated by evergreen shrubs. Shrublands are typical grazing areas for goats but sheep and cattle may also graze.

Open forests or silvopastoral systems are dominated by trees, coniferous or broadleaved (evergreen or deciduous), with a crown density less than 40%. There are several kinds of open forests based on the dominant species. Those dominated by holm oak (*Quercus rotundifolia*) or cork oak (*Quercus suber*) are widespread in Iberian Peninsula and known as *dehesas* in Spain and *montados* in Portugal.

Permanent pastures

Country	Area (1000 Ha)	Percent of the total country
Greece	4,600	35
Italy	4,377	15
Portugal	1,437	16
Spain	11,470	23

Source: FAOSTAT 2007

Key messages:

Grazing lands in southern Europe:

- Occupy about one fourth of its total area.
- Are the most degraded land use types.

WHAT ARE PASTORAL LANDSCAPES?

(P4a, P4b)

Pastoral landscapes are heterogeneous lands composed of a variety of plant communities all or most of them accessed and grazed by livestock. In other words, pastoral landscapes include more than one type of grazing lands interspersed in a particular area and used by one or more livestock species. In addition to animals, pastoral landscapes also include the infrastructure associated with animal activities such as watering points, sheds, corrals, access roads and trails. They may be free roaming, shepherded or transhumance landscapes. The impact of grazing animals is different in these three types of landscape.

In **free roaming** pastoral landscapes grazing animals move freely around without being shepherded. They are found in confined grazing lands and result in the development of fenced landscapes, which are distinct in areas with privately owned pastures. Free roaming pastoral landscapes are also created by non-shepherded production systems in communal lands.

In **shepherded** pastoral landscapes livestock are grazing around with the presence of a shepherd who guides them to certain but different routes every day within the landscape. They are found in unfenced grazing lands including the communally grazed rangelands.

Transhumance pastoral landscapes are created by livestock displacement form lowlands to highlands and vice versa. They are normally elongated grazing corridors with a width of up to 70 m and created along drove roads that animal flocks follow as they move from the winter to summer pastures in late spring and vice versa in the autumn. These drove roads are known as *cañadas* in Spain.

Key messages:

- Pastoral landscapes on communal lands are the most degraded.
- Generally, degradation is higher near or around the points where animals stay, i.e. corrals, sheds, and especially watering points, also known as *piospheres*, than away from them.

HISTORY OF LIVESTOCK GRAZING IN THE MEDITERRANEAN REGION

(P5)

Livestock began to be bred in the eastern Mediterranean in early Holocene, between 10,000 and 6,000 years BC, first sheep and goats and later cattle. This means that the history of livestock grazing in the Mediterranean region is no longer than 8,000 years.

When livestock arrived at the Mediterranean, however, they did not find a grazing – free environment. Wild herbivores were already there grazing for much longer time. This clearly indicates that livestock replaced to a large extent wild herbivores, which became extinct for several reasons, such as climatic change (e.g. glaciation), hunting by early humans or even competition by the introduced domestic herbivores.

Since their introduction to the Mediterranean region, however, livestock became part of the environment with which they evolved together over the millennia. Animals affected individual plants, communities, ecosystems and landscapes and the environment affected animals by developing special breeds.

Nowadays, livestock husbandry is an important economic activity in all four countries (Greece, Italy, Portugal and Spain) with sheep numbers exceeding those of cattle and goats (see table). Among these animals, a large proportion of sheep and goats and a smaller one of cattle (beef cattle) depend on permanent pastures for feeding. They constitute extensive production systems and are the ones that mostly affect Mediterranean ecosystems and landscapes. Sheep and goats are raised in pure or, traditionally, in mixed flocks while cattle in pure herds.

Livestock numbers in 2005 (,000)

Country	Cattle	Goats	Sheep
Greece	600	5,400	9,000
Italy	6,255	945	7,954
Portugal	1,443	547	5,500
Spain	6,464	2,905	22,750

Source: FAOSTAT 2007

Key messages:

- Livestock grazing is an ecological factor of the mediterranean environment.
- Livestock husbandry is an important source of livelihood to Mediterranean people since the ancient times.

LIVESTOCK GRAZING AND DESERTIFICATION

(P6a, P6b)

Desertification of grazing lands and landscapes caused by livestock is a long and complex process that evolves through several stages and involves both vegetation and soil.

As animals graze, they remove parts or whole plants from a particular grazing land. This removal is selective; the most palatable species are eaten first in favor of the less palatable ones, which eventually dominate in the grazed area. This is the last stage of vegetation degradation.

In the meantime, as animals move around they trample the soil with their hooves exerting a high pressure. This pressure results in soil compaction and, consequently, in the reduction of its infiltration capacity. Consequently, the rainwater runs off instead of being percolated into the soil profile. In steep areas, which are common in the Mediterranean pastoral landscapes, the water runoff leads to soil erosion, first sheet but later rill and finally gully erosion. Eventually, the parent rock is exposed and desert-like conditions are created.

Degradation of grazing lands can be evaluated qualitatively by assessing range condition. As **range condition** is defined the current productivity state of a rangeland in relation to its potential. This potential is achieved when the rangeland is properly grazed. Consequently, if a rangeland currently provides more than 70% of its potential production, then its condition is considered as *good*; if less than 30%, then its condition is *poor*; and its condition is *fai*r, if its current production is intermediate. An appropriate criterion to use for assessing range condition class is plant cover.

Whether or not livestock grazing will cause desertification, it depends on several management factors as well as on policies related to the livestock husbandry.

Key messages:

- Plant cover of a rangeland must be more than 70% to ensure sustained production.
- If plant cover is less than 30%, then soil erosion and degradation may occur.

NUMBER OF ANIMALS

(P7a, P7b)

Number of animals is the main factor that affects grazing lands. A standard way to express their impact is to calculate the **stocking rate**, namely the number of animal units per unit area during the grazing period. As *animal unit* is considered a mature ewe and called Sheep Equivalent (SE). All other kinds of animals are converted to SE by an equivalence factor (see box).

If the stocking rate in a grazing land is higher than its **grazing capacity** (see box) then overgrazing occurs. On the contrary, when grazing pressure is less than grazing capacity, then undergrazing occurs. Finally, when grazing pressure equals to grazing capacity then grazing is said to be proper.

Overgrazing removes the vegetative cover and exposes the soil to erosion, but in order to result in desertification the following conditions should be met:

a. Increased stocking rate should be applied for a long time, and
b. Soil and climatic conditions of the grazing lands should be marginal (e.g. shallow and steep soils, dry to semi-dry climate).

If these two conditions are not met, then overgrazing may not cause desertification, because most pasture species are adapted to a heavy grazing pressure and can recover if this pressure is lessened or removed soon enough.

Besides overgrazing, **undergrazing** can also cause desertification, because the plant material not removed by the animals becomes a very flammable fuel to be burned by wildfires that often lead to soil erosion. If not burned, undergrazed lands will be invaded by woody species thus resulting in a loss of biodiversity, which is also a form of desertification.

Key messages:

- Overgrazing is considered as the main cause of desertification in grazing lands.
- Undergrazing may lead to devastating wildfires.

Grazing capacity is the maximum stocking rate that can be applied on a grazing land without impairment of its productivity.

Equivalence factors

Species	Unit
Cow	1.00
Sheep	0.20
Goat	0.17

KIND OF ANIMALS

(P8a,P8b)

The kind of animal is another important management factor affecting grazing lands. This is because the various kinds of livestock have different preferences in terms of species or groups of plant species.

Cattle are considered as **grazers** in the sense that they prefer herbaceous to woody species. Sheep are **intermediate feeders** because they eat both herbaceous and woody species, although they prefer much more the former than the latter group. Goats, on the contrary, are considered as **browsers** because they prefer and eat woody rather than herbaceous species (see table). As a result, their impact on grazing lands is different.

Overgrazing by sheep can result in completely denuded grasslands. In addition, sheep can move in steeper land and longer distances than cattle resulting in the creation of a dense network of trails in sloping grasslands.

Goats have an affinity for the leaves and twigs of shrubs and trees and they are blamed for the destruction of Mediterranean forests. For this reason, special measures were taken in the past to eliminate goats from the forestlands including their total banning from certain Mediterranean countries. Nowadays, however, goats are considered important animals not only for utilizing poor quality vegetation but also for controlling the woody understorey of Mediterranean forests thus reducing the fire hazard.

Key messages:

- Rangeland degradation depends very much on the kind of grazing animal.
- Goats are beneficial to forests unless overgrazing is applied.

Feed preferences of livestock(%)

Species	Grasses	Forbs	Shrubs
Cattle	70	18	12
Sheep	57	23	20
Goat	39	10	51

GRAZING SYSTEM

(P9a,P9b)

Grazing too many animals of the wrong kind in a particular rangeland may not be detrimental to vegetation and soil unless it is done in the wrong season and for a long period within the year. This means that the effects of livestock grazing depend very much on the grazing system employed.

Introducing too many animals in a rangeland early in the season when the soil is still wet and the plant seedlings have not grown up will result in plant uprooting. On the other hand, grazing with excess animals the whole grazing period will result in elimination of several annual species because no opportunity is given to them to grow up and produce seeds, so that they come back again the following year. Also, continuous chewing up of perennials by animals the whole grazing season will not give them a chance to store energy for their regeneration in the following year.

Grazing systems may be continuous or rotational. **Continuous grazing system** involves grazing of livestock throughout the grazing land the whole growing period or year. Such a system is beneficial to the animals because they have the freedom to select the best plants or plant parts available in the pasture. For the pasture itself, however, this system is detrimental because plants are not given a chance to recover. The system is applied in communal grazing lands where more than one farmer have the right to graze their animals in the same area, but without control of the number of animals as well as the season and duration of grazing. Communal grazing lands often represent a “tragedy”.

Rotational grazing system, on the contrary, involves the division of the grazing land into paddocks and the use of them by animals sequentially over the growing season of the year. Such a system is applied in privately owned pastures, where fences can be constructed. By deferring grazing of the rangeland for some time during the growing period, grazed plants have the chance to recover thus avoiding vegetation degradation.

Key messages:

- Rangeland desertification is affected by the grazing system applied.
- Communal grazing if often the main cause of land degradation in rangelands.

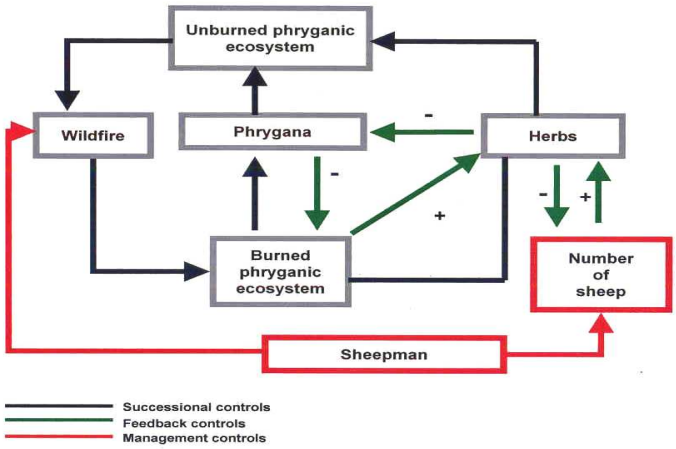
INTERACTION WITH WILDFIRES

(P10)

Fire is a powerful means to control unpalatable to animals' vegetation and Mediterranean pastoralists know it since the ancient times. Pastoral wildfires therefore are an established tradition in several parts of the Mediterranean (e.g. Crete, Sardinia and Corsica). In Greece, for example, a large proportion (25%) of the fire events every year is caused by pastoralists. Wildfires are set during summer, when temperatures are high and vegetation dry. With the advent of the first autumn rains, regeneration of the vegetation occurs in the burned areas through stump sprouting and especially through prolific seed germination of annual herbaceous species, particularly legumes, which are a very nutritious feed for the animals. To make use of this precious feed, pastoralists put into the recently burned areas high numbers of animals, which overgraze the palatable in favor of the unpalatable species. The latter grow up fast due to the reduced competition by the desirable herbaceous species and dominate the burned area forcing pastoralists to set another wildfire to control them and the vicious cycle goes on leading to denuded landscapes.

Both wildfires and overgrazing do not always cause desertification, if applied independently. If combined, however, their result is always detrimental to vegetation resulting in land degradation and desertification.

Combination of wildfires and overgrazing is most commonly practiced in shrublands. In phryganic rangelands, for example, the dominant dwarf shrubs are not palatable to animals, particularly sheep. So, sheep owners often burn them to favor herbaceous species growing right after the wildfire. The regenerated phrygana return back by seed germination or stump sprouting in 3-5 years when a new wildfire is set and so on (see diagram). Wildfires are also used in garrigues and maquis in order to open them up for grazing by livestock, especially sheep and cattle. In these ecosystems, the fire cycle may be longer, i.e. 5-10 years.



A model showing the interaction of vegetation succession after fire with grazing management in phryganic rangelands.

Key messages:

- Wildfires and overgrazing do not always cause desertification, if applied independently.
- If wildfires are combined with overgrazing, the result is detrimental and desertification occurs.

POLICIES

(P11a, P11b)

Desertification by livestock grazing is often caused by wrong policies. These policies may be directly or indirectly associated with livestock husbandry.

A European policy directly related with livestock husbandry and its impact on grazing lands are the subsidies per animal capita that were provided to European farmers in the ’80s and early ’90s. In the Mediterranean countries, such a policy resulted in the increase of livestock numbers raised by farmers, which in turn resulted in overgrazing and desertification in several regions, especially in the dry and semi-dry areas (see booklet A6 for more details). On the other hand, subsidies to livestock pushed farmers to replace many local animal breeds capable of using natural vegetation with more productive breeds but less efficient in utilizing grazing lands thus resulting in their deterioration due to undergrazing

European subsidies affected grazing lands indirectly as well. For example, the economic incentives provided to crop farmers encouraged them to put under cash cropping more and more arable land at the expense of forage crops thus reducing the area available for animal feeding. To compensate for these reduction livestock farmers had to exert more pressure on grazing lands. In certain regions, farmers were subsidized to clear cut natural shrublands such as maquis with machinery and convert them to monocultures of olive groves thus depriving them from livestock husbandry, a practice that also resulted in serious soil erosion in hilly lands. Finally, subsidies for pasture improvement resulted in building excessive access roads and watering points, which also resulted in serious soil erosion.

Similar were the effects of the farm forestry policy under which marginal arable lands were subsidized to be converted to farm forests thus depriving again potential feeding area for livestock who moved to rangelands thus increasing the grazing pressure. For more details on policies see Booklet A6 of this series.

Key messages:

- EU subsidies encouraged farmers to intensify livestock production at the expense of grazing lands.
- Subsidies per animal capita, in particular, resulted in increased livestock numbers and overgrazing of rangelands.

Crete. Crete has a long history of overgrazing but in some areas of the island this overgrazing resulted in desertified grazing lands. Psilorites mountain is a typical case of desertified areas due to improper livestock husbandry practices, especially overgrazing. Since 1980, sheep and goats have increased 3 times, mainly due to European subsidies. As a result, sparse shrublands, which is the last degradation stage of the mountain, were increased by 85% between 1961 and 1989 at the expense of denser shrublands and forests.

M12

Sardinia. Improper agro-pastoral practices such as brush and stone removal, deep tillage and sowing of annual forage species were applied in Sardinia since ’70s in order to improve pastures or create new ones for increased forage production. For converting maquis vegetation to improved pastures, fire and heavy machinery on steep slopes were used resulting in extensive soil erosion in hilly areas. These practices are often very expensive and do not always result in increased pasture productivity but they were carried out only because they were supported by regional subsidies.

P12a

Spain and Portugal. In southwest Spain and south Portugal dehesas and montados, dominated by holm or cork oaks, are threatened by both extensification and intensification of management practices including livestock husbandry. Reduction of stocking rate results in the invasion of shrubs in the understory that competes trees for water and creates a big fire risk. On the contrary, overstocking leads to tree seedling damage, trampling and, eventually, soil erosion. A big concern for these ecosystems is the lack of natural regeneration largely caused by improper grazing activities.

P12b

MITIGATION MEASURES

(P13)

Desertification of grazing lands and pastoral landscapes can be mitigated if degradation process is reversible. This is the case when vegetation has not been totally removed and soil erosion has not become accelerated.

Fortunately, degradation in the majority of grazing lands of Southern Europe is reversible. This is because Mediterranean ecosystems are very well adapted to livestock activities. Even if aboveground vegetation is removed, there are always underground organs (e.g. rhizomes, stolons, bulbs etc.) or rich soil seed banks by which most species can recover if grazing pressure is removed. Some species can be suppressed by grazing for years but recover if grazing is suspended. Also, rangeland soils can be relieved from trampling if animals are removed for some time.

On the other hand, there are thresholds to the resistance of Mediterranean ecosystems to grazing activities. If these thresholds are crossed then degradation is irreversible. Typical cases of irreversible degradation can be found in semi-dry areas where vegetation and soil have been completely removed and bare rocks have been exposed.

If desertification is localized, infrastructure needs to be constructed in order to improve animal distribution all over the landscape and available vegetation is easily accessed and used by livestock. Such an infrastructure includes access roads and trails to facilitate the circulation of animals and farmers, watering points, salting grounds and sheds to house animals at night or during adverse weather conditions.

Mitigation measures in reversible situations could be simple, e.g. deferring grazing for some time, or more complicated. In the latter case, regulation of grazing management and implementation of the necessary vegetation and soil improvements are needed in order to restore productivity. For the success of such measures it will be also necessary to accordingly adjust local, regional or national policies as well solve any administrative or land tenure problems that might prevent grazing regulation. Finally, the necessary funds should be ensured.

Key messages:

- If rangeland degradation is reversible then grazing regulation and vegetation improvements can restore productivity.
- If irreversible, restoration is very difficult and costly or even impossible.
- Mitigation actions are easier and more effective in wet than in dry areas.

GRAZING REGULATION

The first step towards mitigation of desertified grazing lands and landscapes is to regulate grazing management. Such a regulation can be achieved by developing a grazing management plan, which describes the current number and kinds of animals that graze in the particular areas, the grazing system employed and the potential management to be applied so that the desertified area is restored.

Current management of a grazing land can be described by calculating the stocking rate, expressed in sheep equivalents (SE) per ha and year. The formula to be used is the following:

$$\text{Stocking rate} = \frac{\text{Number of grazing animals (in SE)}}{\text{Area used during the grazing period (in ha)}}$$

Potential management of a grazing land can be described by estimating grazing capacity. In order to estimate this capacity, the annual forage production of the grazing land per unit area at the end of the growing period (maximum) under no grazing (protected area) needs to be measured. This production is subsequently multiplied by the proper use factor (see table) and divided by the feed requirements of the animal unit (see box) for the potential grazing period, namely for the period that the grazing land should be grazed. If it is difficult to measure annual forage production, the alternative is to search in the literature for data collected in the same or similar grazing lands. If this is also impossible, then an expert can be asked for his best estimate. The formula for estimating grazing capacity, expressed also in SE/ha/year, is the following:

$$\text{Grazing capacity} = \frac{\text{Area (ha)} \times \text{Annual forage production (kg/ha)} \times \text{Proper use factor (\%)}}{\text{Monthly requirements of a SE (kg/SE)} \times \text{Number of grazing months}}$$

Once estimated, the two parameters are compared. In case that stocking rate exceeds grazing capacity, as it is the case in desertified rangelands, the excess animals should be accommodated in order to stop overgrazing. Possible ways to achieve this accommodation are the following:

1. Increase the forage supply in the existing grazing land by improving vegetation (see chapter on vegetation improvements).
2. Resort to alternative feed resources (see chapter on integrated management).
3. Displace excess animals to another grazing land where no overgrazing occurs.

Proper use factor is the proportion of annual production that should be grazed by livestock in order to ensure proper or sustained use of the grazing land. The value of this factor varies according to the type of grazing land and the species involved. A close approximation is to set it to 50% i.e. "take half, leave half".

Feed requirements

Animal species	Body weight (Kg)	Daily feed (Kg DM/day)
Cow	450	10.0
Sheep	55	2.0
Goat	45	1.7

VEGETATION IMPROVEMENTS

(P15)

Desertified grazing lands and landscapes can be restored by various vegetation improvements aiming at increasing vegetative cover and forage supply to the animals. They include fertilization, introduction of new plant species by seeding or planting and weed control.

Fertilization. If vegetation in a grazing land is overgrazed but not completely destroyed then applying chemical fertilizers with nitrogen and phosphorus can result in its recovery within the same growing season resulting in a considerable increase of forage supply. However, since fertilized vegetation is very nutritious and attractive to animals, the stocking rate must be controlled in order to avoid again overgrazing.

Reseeding. If vegetation is completely destroyed then re-vegetation is needed through reseeding with herbaceous species. The species to be sown must be indigenous to the area or locally adapted and palatable to the animals. Seeds could be over sown on the area or drilled with a special machine after a minimum seedbed preparation. There are two prerequisites for the success of the reseeding: the soil depth should be at least 30 cm and grazing should be suspended until the seeded species are well established.

Shrub plantations. In dry and semi-dry areas, shrubs should be preferred to herbaceous species because they can provide feed to animals during the dry and hot summer period. They can be introduced by planting seedlings prepared in special nurseries. Once planted, they need to be protected from grazing until they get established while their exploitation should be done properly, namely avoiding overgrazing.

Weed control. Unpalatable herbaceous or woody species can be removed from a grazing land with different methods. The least expensive one is the use of prescribed burning by trained specialists. The use of manual or mechanical means is more expensive while herbicides can be effective but may also create environmental problems. Sometimes, weeds can be controlled by changing the animal species, for example, goats instead of sheep as, for example, is the case of woody weeds.

Key messages:

- If spontaneous vegetation is present but suppressed due to overgrazing, chemical fertilization can considerably improve degraded rangelands.
- If spontaneous vegetation is unpalatable or eliminated, then drastic interventions are needed to restore productivity, such as reseeding, shrub plantations or weed control.

INTEGRATED MANAGEMENT

(P16)

Successful mitigation of desertification in grazing lands and landscapes can be achieved if integrated grazing management is applied. Such a management involves the use of alternative to grazing lands feed resources, existing or developed for this particular purpose, so that the high grazing pressure on grazing land is alleviated.

Forests: Adjacent to grazing lands forests can be used for animal grazing during the summer months when pasture growth is limited or dried up. Such forests can be properly treated so that livestock use them without damage of the forest growth. Examples of treatments are thinning of the forest stand or opening up of fire lanes, where animals will be used to control vegetation overgrowth thus increasing the efficiency of these lanes against wildfires.

Artificial pastures: Sown pastures with self-reseeding annual legumes (e.g. *Trifolium subterraneum*), annual grasses (e.g. *Lolium rigidum*) or a mixture of perennial grasses and legumes (e.g. *Lolium perenne* and *Trifolium repens*) can be established in arable lands to be grazed by livestock during spring or autumn. Alternatively, fodder shrubs (e.g. *Medicago arborea, Atriplex halimus,* etc) can be also used to establish artificial plantations for feeding the animals in the critical summer months. All these pastures will alleviate the grazing pressure in rangelands.

Cereal stubble: Cereal crops are traditionally grazed after harvesting in the summer. They can be also used as alternative feed resources to alleviate overgrazing of rangelands.

Hay crops: Growing fodder crops in arable lands to produce hay for feeding the animals in the winter or summer months are another way of alleviating overgrazing in rangelands. In mountain areas, hay can be collected from meadows as well through hay conservation programs.

Key message:

Various feed resources, alone or combined, can be strategically planned within the year so that feed demand of animals is satisfied and grazing pressure on rangelands is reduced (see diagram).

SOCIO-POLITICAL MEASURES

Farmer education. None of the mitigation strategies will completely succeed unless farmers are properly informed and convinced for the need of combating desertification. This means that they should be accordingly educated about the negative impacts of desertification. Such an education can be done by organizing field days in each desertified landscape and demonstrating to them what measures to take in order to improve the situation without jeopardizing their economic prospects.

Land tenure. Sometimes, desertification of grazing lands and landscapes could be caused due to land tenure conflicts. Such conflicts may include ownership / use problems (communal lands). Such problems ought to be resolved before undertaking any other measures to mitigate desertification.

Administrative conflicts. In livestock husbandry, several administrative agencies are usually involved, especially in the case where grazing land does not belong to farmers but to the state or community. In this case conflicts arise among these agencies on how to prioritize the use of these lands and for what group, namely for protection and reforestation or for grazing; or, alternatively, for livestock farmers or the arable land farmers.

Trained technicians. Dealing with desertified rangelands and landscapes requires special knowledge, which needs to be transmitted to the technicians and farmer advisors in special seminars.

Certain specific socio-political measures are the following:

1. *Resolving management problems of communally grazed lands.* This can be done by developing grazing management plans and encouraging farmers to follow them so that overuse is avoided.
2. *Institutionalizing the use of livestock as management factors in protected areas.* Livestock grazing in these areas is instrumental for preserving high biodiversity. Currently is not practiced because of several obstacles including the negative attitude of conservationists against livestock.
3. *Supporting the use of local breeds.* These breeds are using native vegetation more efficiently than improved ones. The support could be financial (e.g. subsidies, prices of the products, etc) or institutional (e.g. only local breeds in certain areas).
4. *Promoting the production of quality animal products.* Such products will encourage farmers to reduce the high number of animals that cause desertification and concentrate on fewer but more productive ones.
5. *Diversifying the farmer income*. Farmers can diversify their income from grazing lands by promoting other activities such as honey production, wild plants collection and agrotourism.
6. *Institutionalizing the use of prescribed fire to improve grazing lands*. In rangelands where farmers are using wildfires to improve rangelands, the legitimate use of prescribed fire can alleviate the problems because is will be used judiciously without causing desertification.
7. *Economic support of farmers*. Such support is needed when farmers have to comply with a specific plan to combat desertification in their grazing land (e.g. reduction of the excess animals). It could be direct (subsidies) or indirect (prices of products).

SUCCESS STORIES

Greece: *Plantation of fodder trees to improve degraded rangelands.*

In northern Greece, a highly degraded communal rangeland was restored by planting black locust (*Robinia pseudoacacia*), a leguminous fodder tree, very palatable to animals for its foliage and fruits. To protect saplings from animal damage in the first years, plastic shelters were used (inset).

(P18a)

Sardinia: S*eeding of burned maquis with desirable pasture species.*

In Sardinia, wild burned maquis rangelands were seeded on the ash right after the fire with palatable annual pasture species such as legumes and grasses. Ash helped species to get established and grow fast ensuring a vegetation cover that both protected soil from erosion and ensured high quality feed to the animals.

(P18b)
.

Spain: *Introduction of fodder shrubs in cereal fields*

In Murcia, Spain saltbushes (*Atriplex* spp.) were established in cereal fields to be used by sheep supplementary during summer when grazing the stubble. Such a practice attracted animals away from the adjacent degraded natural pastures and provided to them a balanced feed of energy (stubble) and protein and minerals (shrubs).

(P18c)

Portugal: *Improvement of montado pastures with legumes*

Low quality pastures under holm oak in a montado silvopastoral system of south Portugal were improved by 2 to 3 times after oversowing annual legumes, particularly subclover (*Trifolium subterraneum*). These legumes ameliorated the feeding value of pasture growth and enriched the soil with biological nitrogen, which helped grasses to grow fast as well.

(P18d)

SELECTED BIBLIOGRAPHY

Bankov, N. 1998. Dynamics of land use/cover changes in relation to socio-economic conditions in the Psilorites mountain of Crete, Greece. M.Sc. Thesis. Mediterranean Agronomic Institute Chania, Crete.

Campos-Palacìn P. 2004. Towards a sustainable global economics approach for Mediterranean agroforestry systems. In: Sustainability of Agrosilvopastoral Systems (Schnabel, S. and A. Ferreira, eds). **Advances in GeoEcology**, 37: 13-28.

Crespo, D.G., A.M.C. Barradas, P.V. Santos and J.P.G. Carneiro. 2004. Sustainable improvement of Mediterranean pastures. **Grassland Science in Europe,** 9: 840-842.

Enne, G., C. Zucca, A. Montoldi and L. Noé. 2004. The role of grazing in agropastoral systems in the Mediterranean region and their environmental sustainability. In: Sustainability of Agrosilvopastoral Systems (Schnabel, S. and A. Ferreira, eds). **Advances in GeoEcology**, 37: 29-46.

Heady, H.E. and R. Dennis Child. 1994. Rangeland Ecology & Management. Westview Press, Boulder, USA.

Le Houérou H.N. 1981. Impact of man and his animals on Mediterranean vegetation. In: Mediterranean-type Shrublands (di Castri, F., D.W. Goodall, R.L. Specht, eds). Ecosystems of the World 11, Elsevier, N.Y., p. 479-521.

Holechek, J.L., R.D. Pieper, and C.H. Herbel. 2004. Range Management, Principles and Practices, 5th Edition. Pearson Pentice Hall, New Jersey, USA.

Olea, L., R.J. López-Bellido and M.J. Poblaciones. 2005. European types of silvopastoral systems in the Mediterranean area: dehesa. In: Silvopastoralism and Sustainable Land Management (Mosquera-Losada M.R., J. McAdam and A. Rigueiro-Rodrìgez, eds). CABI Publishing, Oxfordshire, UK, p. 30-35.

Papanastasis, V.P. and D. Peter. 1998. Ecological Basis of Livestock Grazing in Mediterranean Ecosystems. Proc. Inter. Workshop, Thessaloniki October 23-25, 1997. European Commission, EUR 18308, Luxembourg.

Papanastasis, V.P. 2000. Land degradation caused by overgrazing and wildfires and management strategies to prevent and mitigate their effects. In: Desertification in Europe: mitigation strategies, land-use planning (Enne, G., Ch. Zanolla and D. Peter, eds). European Commission, EUR 19390, Luxembourg, p. 187-198

Papanastasis, V.P. 2004. Overgrazing: An issue associated with desertification. On line: http: // www.kcl.au.uk/kis/schools/hums/geog/desertlinks/indicator/system/issues/issue-overgrazing.htm

Papanastasis, V.P. 2004. Vegetation degradation and land use changes in agrosilvopastoral systems. In: Sustainability of Agrosilvopastoral Systems-Dehesas, Montados (Schnabel, S. and A. Ferreira, eds). **Advances in GeoEcology**, 37: 1-12.

Papanastasis, V. P. and P. Mansat. 1996. Grasslands and related forage resources in Mediterranean areas. In: Grasslands and Land Use Systems (Parente, G., J. Frame and S. Orsi, eds). **Grassland Science in Europe**. Vol. 1: 47-57.

Pulina, G., A. Zanda and G. Enne. 1995. The impact of animal husbandry on the degradation of the soil. In: Land Use and Soil Degradation MEDALUS in Sardinia (Enne G., G. Pulina and A. Aru, eds). Proceedings of the Conference, held in Sassari, Italy 25 May 1994, p. 231-238.

Zucca, C. and C. Zanolla. 2007. Agropastoral activities and land degradation in northern Mediterranean areas: The case study of Sardinia. Mimeographed report.