

MANAGEMENT OF RANGE RESOURCES IN ARID AREAS: GOALS, CONSTRAINTS AND POLICIES

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SUMMARY

Rangelands are one of the most important land use type in the world and represent about 47 percent of the earth's land surface. Rangeland ecosystems, particularly those in arid and semiarid regions are highly susceptible to degradation which is usually result of overgrazing. Other factors contributing to degradation are agricultural expansion, water points establishment, shrub uprooting and wood cutting. About 80 percent of the rangelands area is at least moderately degraded. The productivity of rangelands is highly variable. The uncertainty prevailing in such environments imposed pastoralism as the principal form of rangeland utilization. Overgrazing resulted from the long history of misuse of rangelands resources. The misuse is caused by the overstocking and the inappropriate use of rangelands resources with respect to the grazing season as well as the reduction in the grazing areas. Reduction in grazing areas and their diversity is caused by political issues such as establishment of national boundaries. Overstocking is also caused by socio-economical factors that contribute to keep high animal numbers on rangelands. Collective land tenure put no incentive to grazing controls and lead to overstocking. Expanding dry land agriculture, reduce the size of grazing areas and put more pressure on the remaining rangelands. Inappropriate timing of utilization of ranges resources caused effects similar to overgrazing since it reduced plant vigor and reproduction. Overall, rangelands rehabilitation is technically easy. The most difficult part is the implementation because of the socio-economical context that has been neglected by young technicians in developing countries. Policies required for sustainable use of range resources will vary according to the circumstances and the economic and social instruments by which such policies would be implemented. These policies should be based on local regulation for managing range resources. They have to take into consideration the cultural heritage that will ensure their acceptance by potential users.

Keywords: *rangelands, degradation, overgrazing*

INTRODUCTION

Rangelands represent about 47 percent of the earth's land surface (BSTID, 1990) and support livestock and serve as sources of other important economic products (bushmeat, fruits, berries, medicinal plants, building materials, incense). Range resources, particularly those in arid and semiarid regions are highly susceptible to degradation which is usually result of overgrazing, in addition to agricultural expansion, wood cutting, shrub uprooting, burning and inappropriate distribution. The uncertainty prevailing in such environments imposed pastoralism as the principal form of rangeland utilization. This paper aims to: (1) cover the management of ranges resources, (2) address the overwhelming problems these resources are facing, and (3) discuss the policies to be consider as far as the management of range resources are concern.

World distribution of arid zones

According to Le Houérou (1996), arid zones where trading crops are not possible without irrigation occupy 14.6 Km² (11% of the earth surface). Semi-arid and Hyper-arid areas occupy another 10% and 11.2% of the earth surface. Table 1 presents the geographical and bio-climate distributions of the arid zones. Arid zones are mainly located in Africa, Asia and Australia. In developing countries, large portions of the land are classified as arid or semi arid and are located in the tropical and subtropical zones.

Table 1. Geographical Bio-climate distribution of the arid zones

Continents	Altiplanitiare	Temperate	Mediterr.&Subtropic.	Tropical	Equatorial	%
N. America		460	75	490		7.0
S. America	120	438	55	359	120	7.5
Africa			730	2 172	898	26.0
Asia	800	2300	1 715	600		37.0
Australia			1 100	2 200		22.5

Source : Le Hou  rou (1996).

Within the arid zones, rangelands are one of the most important land use type. They represent about 47 percent of the earth's land surface (BSTID, 1990). More than half of the rangelands area is located in tropical and subtropical regions. About 80 percent of the rangelands area is at least moderately degraded (BSTID, 1990). Range resources are used to achieve many purposes. They are used to support grazing of browsing livestock. About 3 billion head of domesticated livestock are reared on tropical or subtropical rangelands. In addition to supporting livestock, rangelands serve as sources of other important economic products.

Management of range resources in arid areas

In arid environments where the productivity of rangelands is highly variable, herder must have access to very large territory and diversify his activities in order to reduce the risk of drought and inclement weather. The uncertainty prevailing in such environments imposed pastoralism as the principal form of rangeland utilization. Production systems, therefore, relied on two strategies ; diversification in subsistence activities and herd composition and mobility of herds.

Mobility of herds reduced the environmental stress and personal risk and caused less environmental degradation, except in areas of animals concentration such as around the boreholes. Small ruminants herds in these arid regions are rarely confined in the same pasture year-round. They rely on movements that permit to adjust to the spatial variation of forage resources and water. Movements to utilize range resources in these regions used to be utilized according to institutions that elaborated highly regulated land use systems for conservation of standing forage such as "Agdal" in the Atlas mountains of Morocco (Bourbouze 1982) or the "Heima" system in the Arabian Peninsula (Draz , 1978,1990).

Mobility and diversification had sustained these systems for long periods and made them productive. Many authors indicated that in such arid environments, mobility of herds made them produce more and resist better to drought than sedentary in the same conditions (Breman and de Wit, 1983 and Gallais 1977).

The diversification takes many forms ; diversity in activities and diversity in herds constitution. Diversification of subsistence activities between agriculture and livestock is an essential way to cope with climatic risk. In deed, animals may survive even when grain yield is low. In addition, diversification of crops grown is usually considered to overcome the risk of crop failure. The other type of diversification concern herd constitution. Producers prefer to have a lot of animals (especially females) of different kinds and mixture of animal species in their herds. Proportion of the different species (camel, cattle, sheep and goats) varied according to regions. As the environment gets more arid, proportion of cattle diminished while that of goats and camel increased. The diversity of kinds of animals and having large proportion of females insures rapid recovery from stressful situations.

Overall, rangeland ecosystems, particularly those in arid and semiarid regions are highly susceptible to degradation which is usually result of overgrazing. Other factors contributing to degradation are agricultural expansion, water points establishment, shrub uprooting and wood cutting.

Degradation of range resources

In arid zones, phenomena such as overgrazing, the extensive cutting of fuel wood and the cultivation of fragile lands resulted in loss of plant cover and change in vegetation composition. Causes of rangelands degradation for some selected countries summarized in table 2 indicates that overgrazing is the main cause of pastures deterioration.

Table 2. Major causes of rangelands degradation in selected countries

Countries	Causes of degradation					
	Overgrazing	Burning	Wood cutting	Uprooting shrubs	Water points	Cultivation
Cameroon	++++	++++				
Zambia	++++					
Sudan	++++		++++	++++		++++
Somalia	++++					
Morocco	++++			++++		++++
Syria	++++			++++	++++	
Yemen	++++		++++			
Iran	++++		++++			++++

Source: World Agriculture Toward 2010, FAO 1992.

Overgrazing is the utilization of the rangelands beyond the limits they can support. Utilization is inappropriate with respect to season and/or the duration of grazing. Overgrazing is occurring in areas where the pressure on natural resources is high. The conditions of tropical and subtropical rangelands, where large proportion of small ruminants is raised, are in very poor because of the overgrazing. In addition to vegetation deterioration, overgrazing is causing degradation of natural resources, mainly soil. Summary of the soil degradation is provided in table 2.

Table 2. Soil degradation (in million hectare) by type and cause (classified as moderately to excessively affected)

	Water erosion	Wind erosion	Chemical degradation	Physical degradation	Total (million ha)
Regions					
Major causes	in %	in %	in %	in %	
Deforestation	43	8	26	2	384
Overgrazing	29	60	6	16	398
Management of arable land	24	16	58	80	339
Others	4	16	10	2	93
Total	100	100	100	100	100

Source : World Agriculture Toward 2010, FAO 1992.

In deed, the degradation of natural resources resulted in decrease in vegetation cover as well as deforestation which enhance soil erosion. Loss of soil due to erosion averaged some 50 tones of soil per hectare per year. This loss is at least five times the natural rate of soil formation (FAO 1992). It is critical to underline that most of the erosion (water and wind erosions) is taking place in Asia and Africa, 65% and 67% for water and wind erosion, respectively (FAO, 1992). Worldwide, overgrazing by domestic animals, especially small ruminants, caused 29% of the water erosion and 60% of the wind erosion.

Overgrazing: the overwhelming problem of range resources

Overgrazing resulted from the long history of misuse of rangelands resources. The misuse is caused by the overstocking and the inappropriate use of rangelands resources with respect to the grazing season as well as the reduction in the grazing areas. Reduction in grazing areas and their diversity is controlled by political issues such as establishment of national boundaries. Overstocking is also caused by socio-economical factors that contribute to keep high animal numbers on rangelands. Collective land tenure put no incentive to grazing controls and lead to overstocking. Expanding dry land agriculture, reduce the size of grazing areas and put more pressure on the remaining rangelands. Inappropriate timing of utilization of ranges resources caused effects similar to overgrazing since it reduced plant vigor and reproduction. In deed, decisions of grazing never take into consideration range readiness or plants reproduction.

Overgrazing by overstocking

Increased livestock population in tropical and subtropical countries overstocked rangelands. Examples of overstocking are provided by cases such as Algeria where 74% of the Algerian livestock population is kept on rangelands and in the steppe and in Syria, where about 75% of the sheep are located in areas below 250 mm, mainly steppe and rangelands (Treacher 1990). In countries such as Zimbabwe, livestock population increased by 119% between 1964 and 1977. During the last 30 years, stocking rates are estimated to be 3 to 8 times and 10 to 15 times higher than recommended (BSTID, 1990). As secondary factor that explain the increase in small ruminants population is the high proportion of the rural population that generates a surplus of labor, which usually need an economic activity that does not require land ownership.

Increased numbers and densities of small ruminants resulted in a reduction in rangelands carrying capacity. For instance, in Algeria, between 1971 and 1985, the carrying capacity was reduced from 0.18 to 0.09 ewes per ha. In Iran heavy overstocking is estimated to exceed carrying capacity by 4 times (BSTID, 1990). Continued high animal density accelerated the removal of palatable species and the lack of competition permit the growth of species by affecting their vigor and reducing their opportunity of natural reseeding. Decrease in palatable species allows woody shrubs to increase in density as result of overstocking.

Increasing grazing pressure make the proportion of bare soil more and more important and reduce in the mean time the amount of litter directly linked to soil fertility. Increased demand for grazing in common access land lead to progressive erosion and decreased soil fertility, lower water table and loss of biodiversity. Higher grazing intensities result also in soil compacting which is responsible for higher runoff and less infiltration.

As result of the reduction in carrying capacity, small ruminants depend on external feed resources. In Algeria, as it is the case in most tropical and subtropical countries, rangelands contribute little to meet small ruminants requirements, less than 20% while the remaining feed is brought as barley grain, straw and bran (Boutonnet, 1989). The use of external sources of feed (barley), usually subsidized, enhance the increase in small ruminants numbers because meet price is free while that of feed is fixed by government which yield price ratio of the magnitude of 1/12 to 1/15 (Boutonnet, 1989 and Bourbouze 1996).

Land tenure put no incentive to reduce overgrazing

Land tenure influence the viability of the natural resources. Most pastures used by traditional pastoralists are collectively owned or controlled. Collective control of range resources is an excellent way of assuming herd mobility. However, the ownership of the livestock is individual as opposed to collective land status. This opposition between the collective ownership of the grazing resources and the individual ownership of the livestock results in the absence of the maintenance of the grazing areas and favor the uncontrolled competition for the limited grazing resources.

In deed, the ambiguity of the land status, as it is the case in many areas of the Mediterranean region, influence range resources in two manners. On one hand, the collective status of range resources put no incentive to control animal numbers and duration of grazing which resulted in high damage of vulnerable range vegetation. Even if lands that are collectively owned does not imply completely open and unregulated access situation and are only open to potential users, it is still in the advantage of the producers to add as many animals as he can raise capital to purchase or he can contract for. On the other hand, the common use of collective rangelands contributed to their degradation since this status of land enhances the cultivation of the best parts of rangelands which restrict grazing areas to poor conditions lands while increasing the grazing pressure.

Decline of traditional institutions

The ecological integrity of the pastoral systems that sustained their range resources depended on two strategies (mobility and diversification) that relied on institutions developed by people to regulate land utilization. Mobility was decided by the group in large tribal space where rangelands reciprocity exploitation was practiced. Mobility on collective land was managed by institutions that elaborated highly land use for conservation of standing forage as "Agdal" in the Atlas mountains of Morocco (Bourbouze and El Aich, 2000) or the "Hima" system in the Arabian Peninsula (Draz, 1990 and Shoop 1990).

These institutions have been weakened by numerous factors such as new delimitations imposed by administration and that is not in concordance with the tribal one which lead to social conflicts. As consequence of the decline in the power of the institutions elaborated by the collectivity, there is a conversion of ecosystems to open access systems and movements are not decided collectively, but rather by individuals or small group of relatives. Therefore, movements are influenced by properties of individuals to decide where and when to graze. Individual properties involve familiarity with a particular region and personal preferences and physical status (age, family size, social status) as well as his means of production (labour, financial possibilities). In definitive, the introduction of motorization (pick up and track) is changing completely the traditional mobility (Bourbouze and El Aich 2000). Herds' movements among pastures are quickly done and further grazing areas are reached. Motorization made the feed resources and water go to the animals and not the opposite as it used to be. Delivery of water to animal could be achieved by different means depending on the financial status of the producers. The introduction of the motorization lead to the apparition of new leaders who financially are strong but who entertain close relationships with local authority which make them take advantages from all state support and help. Ecological consequences of the introduction of motorization are: 1) the unlimited increase in the grazing pressure since water and feed resources can be tracked and 2) the increase in the duration of grazing on pastures.

Overstocking caused by socio-economical factors

Overstocking is also caused by socio-economical factors. In deed, livestock represents for producers not only livelihood, but a means of accumulating capital, insurance and prestige as well. Therefore, prosperous families are reluctant to reduce their stock. Offered prices to pastoralists are usually too low to encourage them to sell during times of abundance, which keep the large numbers of animals on rangelands.

Now days, under the demographic pressure and the economic change, phenomena of sedentarisation is increasing. Sedentarisation is associated with more demand for cultivation lands. As population become more and more sedentary, the amount of agro-pastoralism increases. The environment is probably too variable to support an agro-pastoral system. All these factors related to the transformation of the pastoral systems make the systems heavily dependent on external feed resources and agricultural by-products. As consequence of sedentarization, number of nomads is decreasing. Shoup (1990) reported that only 50,000 of Syria's 350,000 Bedu are still fully nomadic. Among the reasons of settlements, there is the government programs for which sedentarization is top priority. The aspiration of nomads for better life status (school for kids, hospital, ...) is an other motive. The most prevailing cause is that nomads are forced to become sedentary when their flock size are dramatically reduced after severe destocking due to long period of drought. Nomad settlements result in increase in the grazing pressure on rangelands surrounding villages and water points, distant pastures are abundant and the loss in cultural heritage in running livestock in desertic areas. Sedentarization is associated with loss in plant biodiversity since transhumance has strong cultural and nature conservation value.

In some instances, change in the political conditions such as the creation of national boundaries restricted the movements of animals across frontiers and, therefore, reduced the diversity of ecosystems available to herders which resulted in the increase of the duration of the grazing areas because the strategies of pastoralists (mobility of the herds and the diversification of the resources) were altered.

Support and subsidies by governments during droughts were passive since herders could maintain herd numbers even when rangelands resources are exhausted and led to overgrazing. Cutting government subsidies to concentrate and feed cereals would alleviate the situation. Another subsidizing input that maintain large numbers of animals is the veterinary services since before regulation of carrying capacity was done with droughts and losses of animals due to diseases.

Agriculture expansion

Cultivation on rangelands damage native vegetation that has been cut and make soil more vulnerable to wind erosion especially after the cropping abandon as result of the low and decreasing yields of cereals. Once these cultivated marginal areas are abundant, their grazing values are almost null and it may take decades to the native vegetation to come back. In Syria, in the last 30 years, degradation and the expansion of cultivation has almost completely eliminated the shrub vegetation of the steppe which, now, provide only limited amount of grazing in spring (Treacher 1990). Cultivation of rangelands not suitable for cropping was favored by political priorities to ensure self-sufficiency for cereals in many African countries. Generalization of cultures where it is possible is another factor.

Water points

Establishment of water points on rangelands, instead of increasing available pastures as it is meant to, induce range resources degradation due to the concentration of animals in smaller areas for longer periods. In addition, the establishment of water points without any grazing controls increase the grazing pressure on rangelands previously used infrequently. In fact, lack of water for small ruminants in some arid rangelands limits their use to definite periods of the year and increase pressure on others where water is available. To cope with this problem of shortage of water, small ruminants producers developed different strategies. In some instances, small ruminants producers water their animals every other day (El Aich et al, 1990). Water is a determinant factor in the nomads decisions to move among grazing areas such as the Southern part of Morocco where they based their late spring and early summer movements on the availability of water while grazing areas where water is lacking during winter and early spring. Providing water in winter grazing areas of these desertic ecosystems make the nomads stay more which may threaten the viability of the system and lead to the deterioration of the vegetation. The establishment of water points in some areas without any grazing control damaged the rangelands resources in countries such as Syria. For others small ruminants producers, the widespread availability of trucks facilitate the transport of animals and water to use rangelands previously used infrequently (Morocco, Saudi Arabia). Water can be sold on rangelands in the Middle Atlas of Morocco during season of shortage of water. Trucks are getting specialized in the trade of water to sheep producers using some high mountainous rangelands during summer. As consequence, duration of grazing is increasing. Moreover, during droughts and in order to alleviate the impact of lack of water, governments provide trucks that carry water for shepherders. So, providing subsidized water to livestock by governments during droughts to save livestock is another political decision that contribute to overstocking rangelands by keeping large numbers of animals which result in quick range deterioration and land degradation.

Shrubs up rooting and wood cutting

Another major causes of range resources degradation are the up rooting of shrubs and the cut of wood. Up rooting of shrubs in addition to cultivation reduce drastically the vegetation cover on rangelands and enhance both wind and water erosions. Up rooting of shrubs by pastoralists for domestic use purposes is due to the unavailability of gaz for cooking for many reasons such as the cost. Cuts of wood, in mountainous regions, is common practice to feed leaves to livestock during winter when there is shortage of food, in addition to its utilization for domestic purposes. This practice is usually accomplished with a lot of damage to trees. In the Middle Atlas of Morocco, herders cut branches of *Cedus atlantic* to feed their flock. As result of excessive cut of branches from *Cedrus atlantis*, large amount of these trees are dying. In other areas of Morocco such as the High Atlas, around the villages there are forests managed by the village people who limit the amount of wood that should be cut by every one and the period of the year when it is allowed to cut wood. This is not the case in the steppe where populations cut species such as *Artemisia herba alba* that is well adapted to this environment. Up rooting *Artemisia herba alab* in such environments lead to the colonization of rangelands by species with less pastoral value.

Consequences of range resources degradation: Transformation of livestock productions systems

Dynamics that productions systems in arid areas are going through -reduction in mobility of herds, expansion of cultivation on rangelands (aspects discussed previously)- lead to transformation of the production systems. These transformations concern feeding, choice of raised breeds. In deed, livestock relies less on pastoral range resources, i.e., they represent 6, 12 and 28% of the annual energy requirements of small ruminants in Algeria, Tunisia and Morocco, respectively (Bourbouze et Lazarev 1991). In Saudi Arabia, range forages provide less than 20% of the feed needed by livestock (Sidahmed 1992). During periods of droughts, contributions of rangelands might be even lower. Along with this reduction in the contribution of rangelands, other external resources and agricultural by-products (straw, stubble) are offered which make the system heavily dependent on agriculture. However, the environment is probably too variable to support an agro-pastoral system.

The dynamics of the pastoral systems induced also changes in livestock composition ; less goats and more sheep and cattle. The intensification of the systems that generates forages or grain or other by-products lead to modification of the animals using these resources. Therefore, more productive species are preferred to well adapted ones leading to, loss in rusticity. This is happening in the Eastern Steppe of Morocco where the Beni Guil native breed is replaced by the Ouled Jellal coming from Algeria. The same phenomena is occurring in Tunisia where the fat tail breed (Barbarine) is invaded by other breed more productive from Algeria.

Policies : What to do about deterioration of range resources?

Range resources are easy to destroy for the reasons we discussed previously, but difficult to restore. If left undisturbed, rangelands will, in most cases, regrow and reclothe themselves with vegetation. But this may take long time. In the process of rangelands rehabilitation, governments attempt an array of sound techniques without success. The reasons for this failure are the low knowledge of the functioning of the ecosystems, the fact that range management as science is recent in these tropical and subtropical countries as well as the conflict between the government decisions.

For instance, the sedentarisation of nomads comes the desire of the governments to provide the benefits of development, such as education, health care, to pastoralists. This policy is conflicting with the use of natural resources by nomads which rely on mobility that prevent rangelands from desertification as it was the case for the past time. The policy is conflicting because it induces a loss of cultural heritage about the use of range resources. Moreover, the inclusion of pastoralists in national economies weakens the power of the group in favor of the individuals which reduced the role that the collective played in the survival and reproduction of the pastoral enterprise that relied on range resources. As consequence of the tendency for governments to consolidate power, the balance of responsibility often shift from a local, informal body to a central, formal governing body which lead to new alliances form between individuals and institutions. As this happens, some individuals benefit more than others. In fact, sometimes, political alliances individual growers and the government may become more important than sustainability of production of range resources.

Overall, rangelands rehabilitation is technically easy. The most difficult part is the implementation because of the socio-economical context that has been neglected by young technicians in developing countries. Defining optimal stocking rates or grazing capacity is an easy task. In the mean time, range resources improvements techniques are well known technically. What is difficult is how to implement that on the field with people? In deed, asking producers to reduce the size of their flock is unacceptable. Therefore, what are the possible options for appropriate policies that will result in sustainable use of range resources?

In the light of what has been discussed earlier, policies to be designed should aim to ensure sustainable use of these fragile ranges resources. Such policies have to take into consideration the high variability and uncertainty of the context of these range resources. Interventions of governments, such as provided subsidies and facilities, should be based on adequate understanding of the ecosystems in order to account for local implementation capabilities. Policies required for sustainable use of range resources will vary according to the circumstances and the economic and social instruments by which such policies would be implemented. These policies should be based on local regulation for managing range resources. They have to take into consideration the cultural heritage that will ensure their acceptance by potential users. It is well known that any sound range improvement technique, if imposed by technicians, will be rejected by people. Literature is rich with range resources management and improvement developed by shepherders (Draz, 1978,1990; Bourbouze 1982; Bourbouze and El Aich 2000, and Shoop 1990). For instance, mobility of herds should emphasized in any range resources management program because it ensure a good valorization of high variable resources while preserving them since mobile flock induce less degradation. Range rest and rotation are very antique techniques that have been practiced should be implemented. Again, how to implement these techniques that are part of the cultural heritages of nomads and shepherders in general?

One can think about taxing animals exceeding an average herd size to control carrying capacity? Politicians avoid to bring up this unpopular issue. It seems that the least costly and desirable form of decision making is at the local vs central government level (Rittenhouse and El Aich (1988). Delegation of decision making about range resources management could be accomplished by use of performance bonds. Rittenhouse and El Aich (1988) suggested that legislation would provide for people to have the choice of having the land administrated by the central government or the tribes. If the tribes opted to make decisions, they would be asked to put up a performance bon of sufficient size that if they did not provide proper stewardship of the resource the bond would be forfeited and the money used in renovation projects. If at the end of the bonding period, the resource had the properties agreed on in the bonding contract, the money would be returned to the people (of course a new bond agreement would need to be negotiated for the next period of time).

CONCLUSION

Rangeland ecosystems, particularly those in arid and semiarid regions are highly susceptible to degradation which is usually result of overgrazing in addition to other contributing factors such as agricultural expansion, water points establishment, shrub uprooting and wood cutting. In order to cope with such range resources degradation, rangeland rehabilitation is technically easy. However, the most difficult part is the implementation because of the socio-economical context. Even though, policies required for sustainable use of range resources will vary according to the circumstances and the economic and social instruments by which such policies would be implemented, they should be based on local regulation for managing range resources and must take into consideration the cultural heritage that will ensure their acceptance by potential users.

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