Changes suffered by the Mediterranean rangelands in the recent past: ICARDA's experience

Abstract

In the harsh agro-climatic environment of Central and West Asia and North Africa that the International Center for Agricultural Research in the Dry Areas (ICARDA) seeks to serve, rangelands are of considerable environmental, agricultural, and socioeconomic importance. These rangelands, which contribute to the living of the poorest population of the region, are, however, undergoing major changes. This is a concern reflected in ICARDA's increased attention and resource allocation to research for natural resources management.

Within only four decades, rangelands in Central Asia have evolved from a state of over-exploitation to a state of under-utilization. During the Soviet time, rangeland degradation due to high stocking rates was widespread; rangelands were largely used to produce fine wool and karakul pelts, and their exploitation was based on the availability of a vast network of wells maintained by the State. In northern Kazakhstan, millions of hectares of dry steppe were plowed to meet the grain production goals of the Soviet Union. The plowing of marginal lands resulted in massive losses of rangeland habitats and soil erosion. After the breakup of the Soviet Union, lack of infrastructure maintenance and operating capital and loss of traditional markets for wool and karakul pelts rendered vast areas effectively ungrazeable or unattractive.

Studies in West Asia and North Africa clearly show that in most countries of the region the contribution of rangelands to livestock feeding is diminishing. There is an obvious expansion of rainfed crops (mainly barley) on the best rangelands, as well as an increase of irrigation activities wherever it is possible to establish a water source. Results of a case study in Morocco indicated that the overall state of the non-cultivated vegetative cover had diminished between 1988 and 2000, concomitant with a major increase in the cultivated area. There is also a trend for livestock owners to acquire small pieces of land to settle on and plant fruit trees such as olives, figs, almonds and grapes. The consequence is that the agro-pastoral communities are grazing poorer ranges and staying on them as long as they have water from a well, a cistern or brought in by tanker.

The agro-pastoral system dynamics in Syria is of interest (specific paper about this country was published in the 13bis Annex). Intensification of agriculture and herding has profoundly modified the conditions of exploitation of agro-pastoral resources. Recent history is marked by a clear intensification of use of cultivated land and steppe areas. The introduction of mechanization, which became generalized in the 1960s and 1970s, has permitted considerable expansion of cultivation to the detriment of the steppe, and the practice of fallowing barley fields has been progressively abandoned. Since the 1980s, new changes in the cultivated zone are characterized by an expansion of areas irrigated by groundwater. Sheepherding, most of which takes place in the arid and semi-arid zones, has grown by 10% per year between 1975 and the early 1990s.

The heterogeneity of the vegetative cover in cultivated zones and in the steppe is in fact the result of several variables, ranging from *climatic conditions* to *resource exploitation*, with water availability playing a preponderant role. This was clearly illustrated in a 1:100,000 map of the arid margins of Syria, developed as an aid for the decision-making process for the management of dryland resources. The map provides a combined image of three groups of factors: *climatic conditions*, *physical environment characteristics*, and *resource use by farmers and herders*. Groundwater monitoring studies in Syria have indicated that the exponential increase of motorized irrigation wells has caused severe degradation in the quantity and quality of the groundwater resources along the margins of the rangeland areas. Underground water galleries dating from the Byzantine time have dried up due to the increased pumping from these wells.

Background

Agricultural systems dynamics in Central and West Asia and North Africa

After millennia of food self-sufficiency, the region of Central and West Asia and North Africa (CWANA) is no longer capable of feeding itself. Population growth has already considerably outpaced agricultural production, and the gap between the demand and supply of food is bound to widen even more in the years to come.

Erosion-promoting cropping systems, due to demographic and economic pressures, are having detrimental effects on the environment and have generated serious problems associated with declining soil fertility and inadequate feed supply for livestock. Soil erosion and nutrient exhaustion are becoming ever more common. Scarce water resources are being rapidly depleted, and rangelands are shrinking and degrading.

To meet increasing demands for food and feed in WANA, there is an obvious expansion of rainfed crops (barley mainly) onto the best range in the 150–250 mm zone (Figure 1, page 22). There is also an increase of localized irrigation activities wherever it is possible to establish an irrigation water source on the range in the lowest rainfall zones (100–150 mm). The area available for grazing is becoming smaller with more animals grazing fewer hectares. The perennial vegetation has been almost totally destroyed by overgrazing and firewood collection, leaving the soil exposed. And the ever-decreasing biomass available for grazing encourages land users to plow and grow barley instead, thereby destroying the last vestiges of any dry-season soil cover.

In general, throughout the region, the degradation of the rangelands has reached an alarming degree, calling for prompt action. The capacity of range-

lands as a feed source for livestock and ensuring the sustainable livelihood of herders has been drastically reduced due to the combination of various factors, including degradation due to overgrazing and expansion of cultivation.

Importance of rangelands in Central and Occidental Asia and in North Africa

In the harsh agro-climatic environment of CWANA that the International Center for Agricultural Research in the Dry Areas (ICARDA) seeks to serve, rangelands are of considerable environmental, agricultural, and socioeconomic importance. In West Asia and North Africa rangelands cover over 272 million ha of the zone that receives 100–400 mm annual rainfall and encroach onto the extra 800 million ha of desert country (Table 1 - page 23). In Central Asia, there are over 260 million ha of rangelands.

Throughout the region, rangelands contribute to the living of the poorest population. They provide a large proportion of the feed requirements of livestock grazing and are an important source of domestic milk and proteins. Wood harvest is an important source of fuel for isolated or low-income human populations (Le Houérou, 1991). Rangelands are also a source of biodiversity including medicinal and herbal plants that enhance health care and rural well-being.

The rangelands in CWANA are, however, under increasing pressure. Because of demographic and economic pressures, the sustainability of the rangeland resource base is becoming a major issue. This is a concern reflected in ICARDA's increased attention and resource allocation to research on natural resource management. The present paper highlights, through case studies, some of the efforts undertaken to understand the changes that have occurred in the Mediterranean rangelands in CWANA.

Decreasing rangeland and contribution to animal feeding

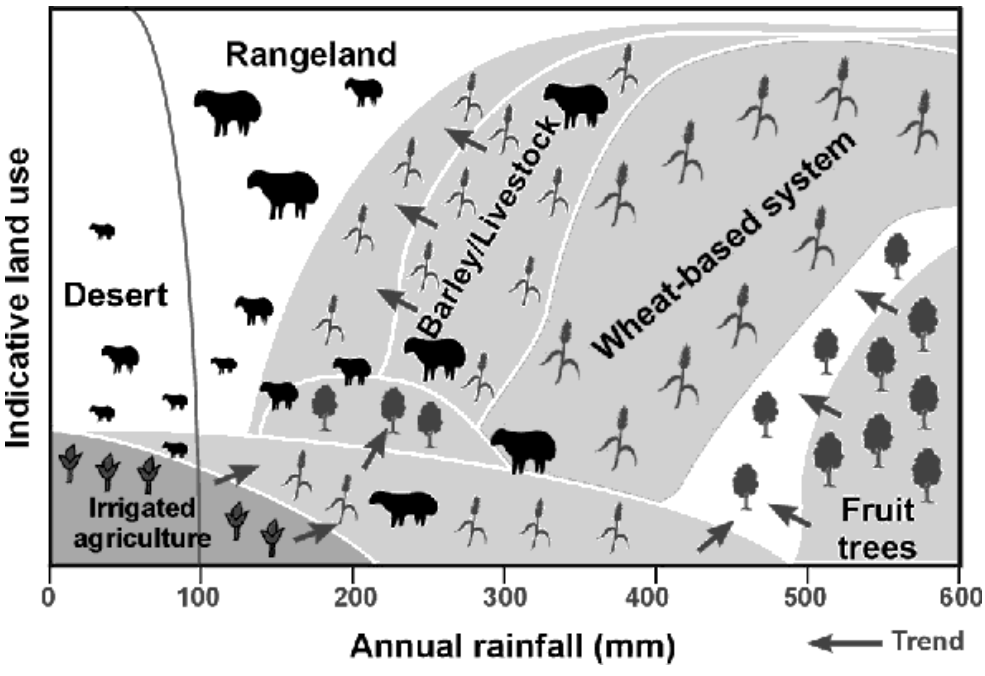
Livestock populations and feed use have generally increased in CWANA over the past two decades due to rising economic demand. With rangelands stocked beyond their capacities, animal diets have been shifting toward greater use of crop residues and concentrates.

Shomo and Ngaido (2001) compared the 1976–80 and 1996–2000 contribution to animal feeding of the three feed categories: (1) crop residues and forage crops, (2) rangeland grazing, and (3) feed grains and other concentrates, which nominally add up to 100% of feed use for any country at a given point in time. Figure 2 - page 24 shows the contribution of these three feed categories to animal feeding. Contrasts in the feed-resource endowments and general shifts toward greater proportions of feed grains and crop residues, away from rangeland, are most spectacularly apparent in Ethiopia, Jordan, Kuwait, Qatar, Saudi Arabia, Sudan and the United Arab Emirates. Excepting the cases of Afghanistan, Kazakhstan, Tajikistan and Uzbekistan, all the countries show rangelands as diminishing proportions of livestock diets. This is simply the outcome of increased livestock populations, increased cropping activities (generating crop residues), and increased use of feed grains, taking no account of range degradation.

Loss of rangeland biodiversity and vegetation cover

Rangelands in the CWANA region encompass a wide plant genetic diversity. For example, in the Matrouh Governorate, along the northwest coast of Egypt, there are several adapted and valuable plants. The species worth noting include *Periploca angustifolia*, once on the plateau and now taking refuge in the wadis; *Ephedra aphylla* (a medicinal plant) hanging from the cliffs; and *Retama retam* (a valuable legume shrub producing fuel wood and fruits that are good forage). A valuable fodder shrub and a perennial Crucifer with fleshy leaves, *Moricandia nitens*, is likewise found throughout the area and grows as tall as 1.5 meter on top of a cliff at a steeply incised wadi east of Marsa Matrouh. Abundant and unexpected also is the presence of *Dactylis glomerata* (var. *hispanica*), the famous cocksfoot pasture grass found at the edge of the plateau and hiding in the wadi's steep slope, and also *Oryzopsis miliacea* and *Hyparrhenia hirta* growing on sandstone soils in the very eastern tip of one of the wadis west of Marsa Matrouh.

Pastoralists in the Arabian Peninsula identified six native rangeland species: *Pennisetum divisum*, *Panicum turgidum*,



D'après Le Houérou (1991)

Figure 1 - Changes occurring in land use in West Asia and North Africa

Pays	Steppe (100–400 mm)	Désert (< 100 mm)	Total
Afghanistan	220	427	647
Algérie	210	1990	2381
Egypte (hors Sinaï)	30	910	1001
Egypte (Sinaï)	5	55	60
Iran	685	951	1636
Irak	291	96	435
Jordanie	40	43	98
Koweït	18	0	18
Libye	90	1670	1760
Maroc	120	303	620
Oman	12	198	212
Pakistan	312	467	779
Palestine	5	7	21
Qatar	0	22	22
Arabie Saoudite	200	1940	2150
Syrie	157	10	185
Tunisie	55	60	164
Turquie	110	0	781
Emirats Arabes Unis	0	84	84
Yémen	160	312	530
Total	**2720**	**7700**	**13584**

Table 1 - Steppe and desert areas in WANA (x 1000 km^2)

Cenchrus ciliaris, *Dipterygium glaucum*, *Coelachyrum piercei*, and *Stipagrostis plumosa* as the most important forage grasses, legumes, and shrubs. In eastern Morocco, native rangeland species include *Stipa* spp., *Artemisia herba-alba*, *Helianthemum* spp., *Herniaria* spp., *Paronychia argentea*, *Schismus barbatus*, and *Thymus* spp.

In Central Asia a great number of endemic rangeland taxa thrive in the deserts. These represent a gold mine with huge potential to reverse land degradation in fragile desert environments in central Asia as well as in other parts of the world. Species with potential for rangeland rehabilitation include a number of *Astragalus*, *Colutea*, *Dactylis*, *Melica*, *Stipa*, *Plantago*, *Artemisia*, *Haloxylon*, *Salsola*, and *Atriplex* genera. There are, however, indications that genetic erosion is occurring in CWANA rangeland. Genetic diversity is seriously declining through the degradation of their natural habitats, intensification and expansion of cultivation and overgrazing in natural rangelands.

During a recent survey in Morocco, rangelands in all geographical areas were found to be overgrazed. Perennial grass species could only be collected in protected areas between cropped or horticultural fields and along roadside verges or in reserves. The sampling of only 22 accessions of *Phalaris aquatica*with only one of these coming from the Rif mountainsis clear evidence of severe genetic erosion of this species, which was previously reported to be abundant in higher-rainfall regions of Morocco, especially in the Rif mountains. In eastern Morocco, evidence from the field suggests an irreversible degradation of *Stipa tenacissima* steppes into shrub steppes.

In Jordan, the continuous and accelerating over-exploitation of medicinal and herbal plants in their natural habitats, combined with the increasing demand for such plants, have led to destruction of the natural stocks in the wild. Many of the medicinal and herbal plants are endangered and some are threatened with extinction. For example, the habitat of the wild saffron *Crocus hermoneus*, a species that has been collected only from a restricted area in Amman, has been replaced by residential areas (Al-Eisawi, 1998). A recent study (GCPE, 1998) shows that *Origanum syriacum*, which was once widely distributed, is now confined to a small area east of Jerash because of expanded fruit tree plantations. Other species are becoming rare (*Daucus jordanicus*) or endangered (*Capparis decidua*). A case study in Syria is detailed below.

In Syria, cutting of trees and shrubs has deprived the animal population of an important source of forage of great value during certain seasons of the year. As a result of overstocking, the more palatable sub-shrubs, perennial grasses and legumes such as *Salsola vermiculata*, *S. lancifolia*, *Dactylis glomerata*, *Oryzopsis* spp., *Hordeum bulbosum*, *Aristida* spp., *Stipa barbata*, *Astragalus* spp., *Onobrychis* spp. have been replaced throughout the Syrian steppe by the less palatable plants such as *Noaea mucronata*, *Peganum harmala*, and several spiny shrubs of very low forage value (Draz, 1980). Where *Poa sinaica* had been the dominant species, overgrazing has encouraged an increase in the *Carex stenophylla* population that is a less productive species. Sankary (1993) listed more than a hundred rangeland species that threatened by loss of diversity or even extinction from the rangeland of the Middle East.

Case Study: biodiversity and vegetation cover in the Khanasser Valley, Syria

An investigation was conducted in the Khanasser Valley, located approximately 70 km southeast of the city of Aleppo in northwestern Syria, to study the regenerative capacity of the overgrazed areas in the Valley (Zöbisch et al., 1999). Six typical sites were selected on the stony western and eastern foot slopes. At each site, four monitoring plots were identified. One of these plots (10 × 10 m) was fenced to protect it from grazing. The other three plots (5 × 3 m) were left open, freely accessible to the animals and grazed by the flocks in the

usual way. On all plots, plant-cover development, the presence of plant species, plant biomass, soil organic matter and aggregate stability were measured.

At the beginning of the measurements (March 1998), the average plant cover on all plots was 12%. After fencing, the protected plots reached a maximum 25% cover in May 1998. At this time, plant cover of the grazed plots had already decreased to about 7%. During summer 1998, the protected plots remained with a cover of about 20% while there was still a further reduction of plant cover on the grazed plots to about 5%. After the onset of the rains in October/November 1998, re-growth began immediately. Within a period of just two growing seasons, the cover on the protected plots had recovered beyond 50%.

There were clear differences in the number of plant species between the grazed and the protected plots. Already after the first rainy season (1997/1998), the protected plots overall had nearly three times the number of species than the grazed plots. During the second season (1998/1999), the protected plots showed a slight increase in the Species Index from 81 to 83%. However, on the grazed plots the Species Index increased from 29 to 36%.

After one season, 71 plant species were identified in all the monitoring areas; 81% of the species were found on the protected plots, while only 39% were found on the grazed plots. During the two consecutive seasons, 104 plant species were identified; 84% were found on the protected plots and 36% were found on the grazed plots. Observations also revealed that the total aboveground biomass production on protected sites was four to ten times higher than on grazed sites.

After two seasons, the organic matter of the topsoil on the selected sites showed a remarkable difference between the protected and the grazed plots. On the grazed plots, organic matter ranged between 2.2 and 2.3%. On the protected plots, the organic matter values were between 2.8 and 3.0%. The percentage of aggregates >0.5 mm was about two times higher on the protected plots than on the grazed plots. The percentage of the smaller aggregates (i.e., 0.5 – 0.2 mm) was also higher on the protected plots.

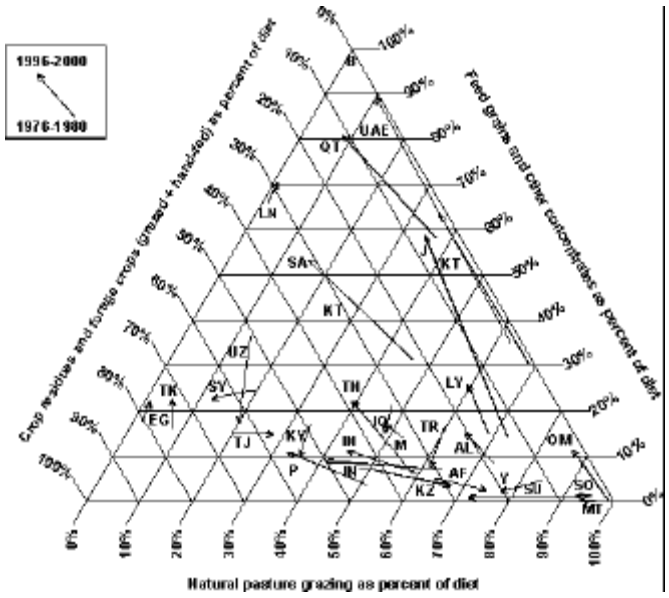


Figure 2 - Compositions of livestock diets, by feed category: 20-year trends (1976-80 to 1996-2000) for selected countries of Central/West Asia and North Africa (Shomo and Ngaido, 2001)

Key: AF=Afghanistan; AL=Algeria; B=Bahrain; EG=Egypt; ET=Ethiopia; IN=Iran, IQ=Iraq; J=Jordan, KZ=Kazakhstan; KT=Kuwait; KY=Kyrgyzstan, LN=Lebanon; LY=Libya, M=Morocco; MT=Mauritania; OM=Oman, P=Pakistan; QT=Qatar, SA=Saudi Arabia; SO=Somalia; SU=Sudan, SY=Syria; TJ=Tajikistan; TN=Tunisia; TR=Turkmenistan; TK=Turkey, UAE=United Arab Emirates; UZ=Uzbekistan; Y=Yemen.

Decreasing rangeland productivity

Case Study 1: rangeland monitoring in the Syrian Steppe

To assess range conditions in the Aleppo/Hama steppe, a study was undertaken to measure seasonal biomass in selected rangeland types: *Artemisia herba-alba* rangeland and its degraded condition, annual vegetation range type, degraded *Noaea mucronata* range type, and *Haloxylon* range type. This information may serve as a reference to monitor range trend over years (Gintzburger et al., 1999). Protected areas as well as unprotected areas located within the study area were monitored. Measurements were made on a regular basis in order to provide information on the potential feed production of regenerated areas and thus contribute to the definition of appropriate regeneration and grazing management strategies. Aerial biomass and soil moisture profiles were measured monthly from January 2000, both on open and protected homogenous range sites. Figure 3 - page 25, showing *Artemisia herba-alba* aerial biomass from an open site (Bir Hammam) and a protected site (Ain-Zarqa), clearly shows that the potential productivity of open grazing rangeland is lower than that of protected areas.

Case Study 2: rangeland productivity in relation to distance from settlement in Kazakhstan

The transition to non-centralized economies has had a dramatic impact on rangeland use in Central Asia. Before 1991, transportation and water supply were provided by the state, allowing rotational grazing and the use of remote range areas. Nowadays, smallholders are unprepared to use ranges beyond the village periphery. Ranges close to villages are subjected to heavy grazing pressure, while remote ranges appear to have negligible grazing loads.

A study was conducted in the Berlik Community located about 80 km from Almaty, Kazakhstan, to investigate the effects of alteration of grazing practices. The study shows that use of ranges further from the village appears to be limited by labor, transport, and water availability. Transect data revealed a greater proportion of annual and alkaloid-containing species on ranges at village outskirts than at distances beyond 3 km (Figure 4 - page 26). Similarly, range productivity decreases as distance from settlement increases (Figure 5 - page 26). The reliance upon ranges at the village periphery may signal a break down in traditional systems of common herding of household livestock. Organization at the village-level to introduce grazing rotations may alleviate current grazing pressure on rangelands near villages.

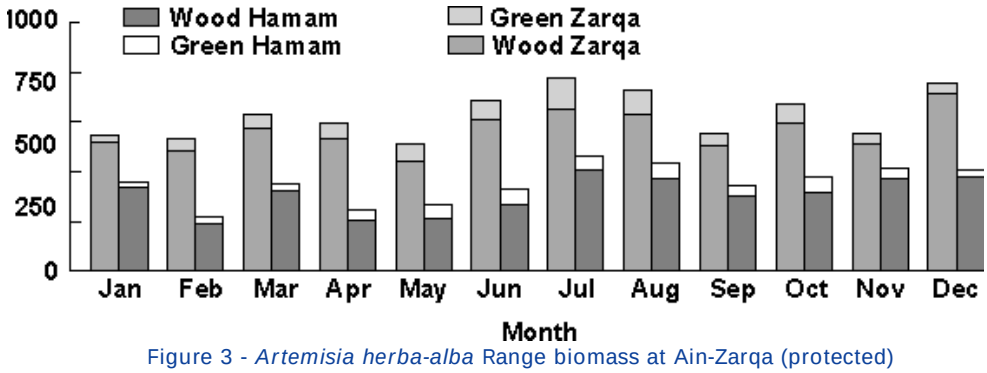


Figure 3 - *Artemisia herba-alba* Range biomass at Ain-Zarqa (protected) and Bir-Hamam (grazed) in Northern Syria (2000)
Wood = Woody parts of *Artemisia herba-alba*

More cereal cultivation encroachment in rangeland

Expanding human demand for meat and milk in WANA has resulted in a general increase of national flock size (Nordblom and Shomo, 1993). This puts the pressure on grain and straw supply. As new arable land is not anymore available in higher rainfall zones, crop expansion takes place mostly into the marginal cropping and low rainfall zones of WANA, largely encroaching into rangelands (Gintzburger et al., 1997). Rangelands continue to be under severe strain from uncontrolled barley cultivation. The increasing small ruminant populations are confined to a shrinking grazing land, inducing more land degradation.

Case Study 1: impact of cultivation, human and sheep population on Syrian rangelands: the case of Jub al-Jamaa community before and after the 1994 cultivation ban

For centuries, cultivation of rangelands was very limited in Syria. But throughout the 1950s and the 1960s, the fast increase in human population led to a sudden wide extension of rangeland cultivation and substantial increase in the sheep population (Figure 6 - page 27). This resulted in rangeland degradation and a decrease in the contribution of rangeland grazing to the animal yearly diet from about 50% in the late 1940s to about 10% in the 1990s (Nordblom and Shomo, 1993).

A study undertaken with the Jub al-Jamaa community to assess the impact of cultivation, human and sheep population on rangelands illustrate this trend (Arab et al., 1998). The study was a collaborative work between the Syrian Agricultural Research center, ICARDA and IFPRI and is part of a community modeling exercise that will identify the best technological package, policies and property rights options available. Jub al-Jamaa community is located in the steppe, 115 km southeast of Aleppo. The yearly mean precipitation is less than 200 mm.

Data were collected in 1998. Visits were organized to discuss with different community leaders the division of grazing land by family group of the Jub al-Jamaa community. Information was also obtained pertaining to the socioeconomics of each household within the 26 divisions. All the interview records were supplemented by GPS data, thus allowing it to be georeferenced. Landsat TM satellite images were processed for the area from two dates, 1988 and 1995, allowing analysis of temporal land use change.

The households of Jub al-Jamaa remained nomads until the mid 1950s. They were moving to areas where grazing and water was available, keeping Jub al-Jamaa as a base to spend time on their way from the rangeland in the southeast to the agricultural areas in the North. There was little cultivation in the rangeland.

The agrarian reform law in 1958 granted all Syrians open access to the rangelands. With this law, pastoralists were allowed to cultivate, under license, a maximum of 45 hectares per capita. Barley cultivation increased and pastoralists started to settle and build houses, and their economical activities changed from sheep breeding to integrated agro-pastoralism.

In Jub al-Jamaa, barley cultivation was practiced for 45 years. This has caused heavy degradation in 40% of the natural grazing areas of the community (Figure 7 - page 27). The licensed cultivated area was 6000 hectares, but the actual area cultivated was 12,263 ha. The contribution of the steppe grazing in the yearly diet of the sheep was about 50% before 1950; it is not more than 11% at present.

Because of the widespread barley cultivation and the ensuing degradation occurring throughout the Syrian rangeland, the government made a decision to ban cultivation in rangeland in order to protect natural vegetation (December 6, 1994 circular No. 4553/1). This had the effect of substantially reducing barley cultivation in rangeland and reducing sheep numbers that were dependent on the barley crop (Figure 6 - page 27).

Currently the community is working with various organizations to reverse rangeland degradation. In particular, ICARDA, in collaboration with the Syrian Ministries of Agriculture and Education and the World Food Program, is renovating the roman cisterns in the community to provide water for domestic use and animals. This will reduce

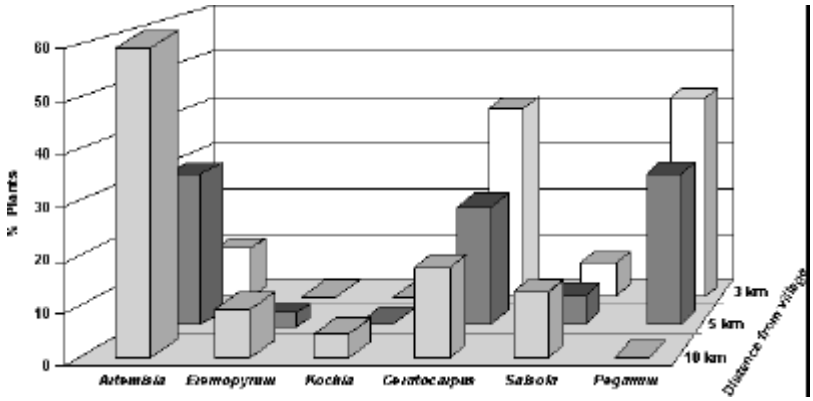


Figure 4 - Kazakhstan: rangeland species according to distance from settlement (Alimayev, 2001)

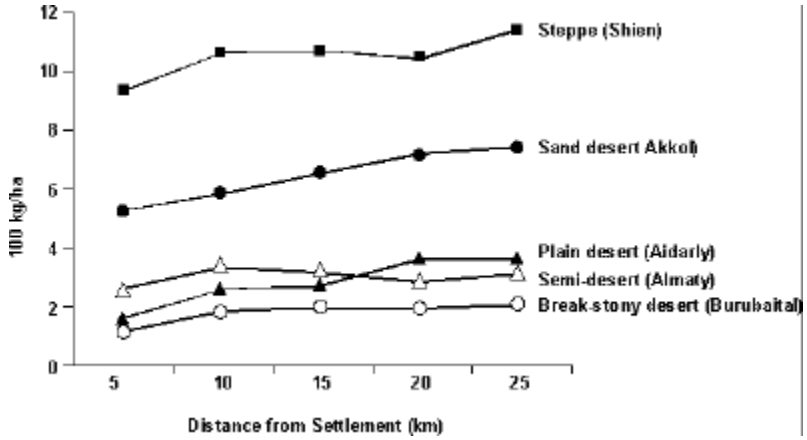


Figure 5 - Kazakhstan: range productivity in relation to distance to settlement (Alimayev, 2001)

damage to the rangeland caused by the daily traffic of water tankers from late autumn to early summer.

Case Study 2: land use and encroachment of agricultural practices into traditional rangeland in Ain Beni Mathar Rural Community, Northeastern Morocco

Within the context of the "Sustainable Management of the Agro-Pastoral Resource Base in the Oujda Region (Morocco): A Regional Approach" Project funded by the Swiss Agency for Development and Cooperation (SDC), ICARDA and the National Institute for Agricultural Research, Oujda, Morocco conducted an investigation on land use and encroachment of agricultural practices into traditional rangeland in Ain Beni Mathar Rural Community, northeastern Morocco. To assess the extent of the encroachment of agricultural practices into traditional rangeland, two LANDSAT-TM satellite images were used: March 1988 and March 2000. The comparison between 1988 and 2000 indicated that natural resources degradation is progressing, in particular:

- the *Stipa tenacissima* steppe in good condition decreased from 22,457 ha to 15,929 ha;
- degraded *Stipa tenacissima* increased from 54,149 ha to 56,188 ha;
- overall degraded area increased from 53,541 ha to 72,228 ha, an increase due to the clearing of *Stipa tenacissima* and *Artemisia herba-alba* steppes;
- degraded *Artemisia herba-alba* steppe decreased from 5,674 ha to 1,354 ha, mainly due to cultivation of these steppes;
- irrigated area decreased from 1,818 ha to 1,617 ha.

Case Study 3: land use and vegetation cover of the arid margins of Syria

A multidisciplinary study of the land use and vegetation cover of the arid margins of Syria was conducted study in the arid and semi-arid areas of Aleppo and Hama provinces (Jaubert et al., 1999). The study focused on the man-environment relationship, the dynamics of transformation in the physical and human environment and their interactions in arid and semi-arid areas.

The study area includes a variety of production systems, ranging from sedentary farming to nomadic herding, which are common in arid and semi-arid areas of the Middle East. It also includes, in the northeast, a large irrigation scheme, which is part of the Euphrates basin project. Satellite imagery was used in conjunction with topographical maps and statistical data from the Ministry of Agriculture. The latter provided information on land use at the village level and the classification of these in the different agricultural zones.

A total of 11 thematic maps and a 1:100,000 land use and vegetation cover map were produced. These allow the identification of degraded steppe areas. The land use and vegetation cover map, which provides spatial information on the overall region is presented in Figure 10. The extension of cultivation in steppe areas in the late 1980s is assumed to be the main factor responsible for the degradation of steppe vegetation. Areas that were brought under cultivation now have very low biomass production. The vegetation is composed mainly of annuals. These areas are now located and quantified; this information is essential for identifying priority areas where rehabilitation efforts and planning should be undertaken. The actual potential will depend on the availability of water and the control of access, both of which are highly variable according to location. The study provides basic information on the hydrology of steppe areas and allows planning for further studies focused on access control.

Tenure and socioeconomics

Case Study 1: the impact of tenure on range quality in Kohlan-Affar, Yemen

For a long time, and because of the widespread use of the "*hema*" system, which protects areas from grazing or cutting for a certain period of time, rangelands in Yemen were managed in an efficient and sustainable way. Grazing pressure was adequate to allow maintenance of species diversity and a high turnover of biomass to meet animal needs. However, in recent years deterioration of rangelands has increased.

A study was conducted in Kohlan-Affar, in the northern mountains of Yemen, where rangelands are the principal feed resource for livestock (Al-Khawlani and Mufarih, 2001). They provide a major source of income to farmers, as well as wood for fuel, charcoal production and construction. Covering about 30% of the area, they include woodland, bare rocky ground, steep slopes unsuitable for cultivation, and collapsed terraces. The investigation assessed plant cover, biomass and species composition under various systems of grazing, in the midslopes and highlands in spring and summer 1996.

The results show that the various systems of grazing lead to varying degrees of degradation: communally owned range showed all signs of overgrazing, while restricted, privately owned range has a high density of palatable plants. The impact of different systems of grazing was clear on the midslopes. There, the richest vegetation was in a site where grazing was restricted by the range owners during the growing season. Grasses are harvested first by the owners before the range is opened for grazing. Grasses covered 85% of the area (primarily *Hyparrhenia hirta* and *Themeda triandra*), and unpalatable plants covered just 6%. The biomass of the grasses was about 1 400 kg/ha, 35 times greater than in an open-access site where half the total plant cover (58%) was unpalatable (such as *Forsskaolea* spp. and *Flaveria trinerva*).

At a mid-altitude site, the community periodically chose to restrict grazing to permit regeneration, but generally allowed open access. Unpalatable species covered 60% of this land, and palatable plants only 6%. This pattern was repeated in the highlands. An open range was exposed to erosion, with just 30% total plant cover (66% of which was unpalatable species such as *Thymus serpyllum*, *Acanthus arboreus* and *Euphorbia schimperi*). In comparison, a restricted rangeland, where the community decides which slopes shall be grazed each year, had twice the plant cover, 60% of which was palatable grasses, primarily *Tetrapogon villosus* and *Eragrostis papposa*.

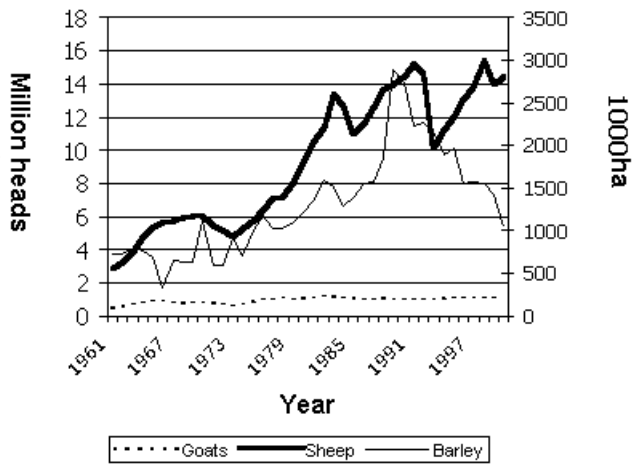


Figure 6 - Evolution of barley cultivation areas and livestock numbers in Syria (1961-2000)

Jabal Sinjar is about 120 km from Mosul city, near Iraq's northern border with Syria. The mountain area of Jabal Sinjar is home to extensive seasonal rangelands combined with cropping systems including cereals and tobacco. There are two distinct patterns of range use in the Jabal. The transhumant system accounts for approximately 75% of the livestock population. These rangeland users come from villages surrounding Jabal Sinjar, though many of them own land within the Jabal. The residents of Jabal Sinjar, particularly the villages of Kersy and Kolkan, use the sedentary system. They practice mixed farming, combining pastoralism with cropping. Livestock use the rangeland all year except during summer, when livestock from both systems graze stubble and straw from the harvest of wheat and barley. With all livestock grazing crop residues, no tent can be seen in the Jabal. In winter, grazing is supplemented by feeding, similar to that of the transhumant system.

There are clear signs of degradation as certain ranges are becoming over-grazed, causing the most palatable plant species to be replaced. A diagnostic study (Mahdi et al., 2001) was carried out in conjunction with physical assessment of the rangeland condition and discussions with farmers, to produce an overview of how socioeconomic factors such as migration of landowners have impacted a mixed pastoralist system already affected by limited water resources.

In the Jabal the actual stocking rates vary from approximately 1.5–2 head/ha, and the estimated stocking capacity varies from 1.3–3 head/ha. This is because the grazing choices made by pastoralists are not solely dependent on the availability of biomass. Land tenure and property rights affect the motivation of farmers to ensure rangeland is not overgrazed. All pastoralists have open access to rangelands, to which there are no specific property rights. There is no public institution to organize grazing, and there are no regulatory management measures. Individual pastoralists decide which ranges to utilize each season, and move either directly from their village to their chosen area, or by gradual movement

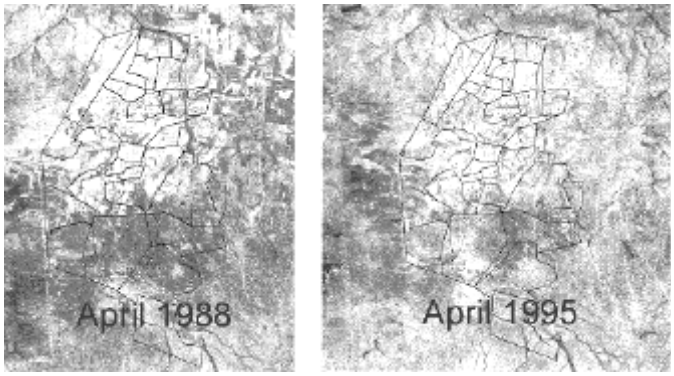


Figure 7 - Landsat TM images showing the physical characteristics of the area in April 1988 and April 1995
The darker grey areas indicate higher natural vegetation cover

along a grazing trajectory until they reach the chosen area and pitch their tents. The 40% of land area that is forested is controlled by a public authority, but sheep have open access to grazing in forests.

In conversations and semi-structured interviews pastoralists cited the problems that limit the productivity of their flocks, and restrict their ability to utilize the rangelands, as they would wish. The primary constraints to grazing are lack of drinking water and the presence of poisonous plants. These constraints are confirmed by the rangeland assessments, where forage by the Jabal Sinjar road was not used, due to lack of water, and the highest biomass in the Jabal, at Sheraf Addeen, could not be grazed due to the abundance of *Hordeum glaucum*. If these constraints were removed pastoralists could spread their flocks over a greater area, taking pressure off over-grazed sites and increasing the productivity of their flocks.

Another constraint, which the farmers cited, was lack of veterinary services. In addition to reducing the health and productivity of individual flocks, lack of disease control affects the whole area, while the presence of veterinary services elsewhere acts as a disincentive to remain in the Jabal. Farmers' flock size is constrained by the lack of concentrated feed in winter months. Further research would be needed to determine whether this is due to a failure of markets to bring feed into such an isolated area, or whether this is due to degradation or insufficient supply of forest by-products on which livestock are fed in winter. Finally, herders do not have sufficient mechanisms through which to market animal products. An inability to sell animal products is a clear disincentive to increase production, and if the market undervalues livestock products, the herders themselves will undervalue the natural resource base on which they depend. An effective market for livestock products is thus necessary for pastoralists to benefit from improved rangeland.

Water challenge for rangelands in West Asia and North Africa

Although the steppe, which occupies a vast area of the WANA countries, is marked by its low precipitation, the total volume of rain that falls on these areas is substantial. Unfavorable surface conditions, shallow soils, limited vegetative cover and high intensity rainfall events cause a substantial amount of the rainfall water to runoff by surface flow to natural depressions and salt sinks. Thus, only part of the limited rainwater will infiltrate and recharge soil moisture and groundwater resources, whereas the other part will return to the atmosphere by evaporation or may be effectively lost due to quality deterioration. The degradation of the native, vegetative cover of the rangelands exacerbates the problem, by leaving the often already shallow soils susceptible to erosion by wind and water. The unprotected soils are also affected by crusting and sealing, properties that are found in many soils in the dry areas. The resulting dense surface crust severely restricts infiltration.

In natural rangelands in the dry areas, vegetation concentrates in favorable locations, often covering only part of the surface area, thus, profiting from the surface runoff of the surrounding areas. This natural sustainable system of harvesting water from a large area to concentrate it for beneficial use on a smaller area has been copied by man.

ICARDA has been actively promoting the use of rainfall water harvesting to improve natural resource management and agricultural production in the dry areas (Oweis et al., 2001). Micro-catchment systems, which collect surface runoff over a distance of less than 100 m, have a high potential in the dry areas of WANA, because they can be implemented by local farmers using commonly available resources. These micro-catchment water harvesting techniques are based on a modification of the soil surface, e.g., by small earth and stone dikes or pits. Micro-catchment systems that are used to create a favorable environment for the re-establishment of rangeland vegetation include pits, contour ridges, and semi-circular bunds. Other successful water harvesting techniques that have for centuries sustained the population in the dry areas of WANA include the well-known *cisterns*. These underground storage reservoirs or tanks, which are often dug out in shallow rock formations, harvest surface runoff from small catchment areas. They provide water for livestock and human use and sometimes also for irrigation of small plots.

Obviously, rehabilitation of the large areas of degraded rangelands of the WANA region requires more than human sweat. Machines and tillage implements have been introduced and developed by ICARDA and her cooperators for the mechanical construction of micro-catchments. These machines include a camel pitter and land imprinter (Gintzburger, 1999) for the reseeding of degraded rangeland. The micro-depressions created by these machines induce not only the collection of water, but also of soil particles, organic matter, and seeds.

In Mehasseh research center, located 120 km east of Damascus in the Syrian steppe, the Directorate of Irrigation and Water Use of the Syrian Ministry of Agriculture and Agrarian Reform, in collaboration with ICARDA, has re-established a large area of rangeland vegetation using different micro-catchment water harvesting techniques. The planting of *Atriplex halimus* and *Salsola vermiculata* seedlings behind semi-circular bunds with a diameter of 2 and 4 meter gave a survival rate of 96% on a 5% slope and 74% survival on a 2% slope. Rainfall of the three analyzed seasons (1995-1998) varied between 93 and 192 mm. The planting of shrubs in bunds along the contour that were made with a mechanical tillage implement had an overall shrub success rate of 93%. The survival rate increased slightly with greater spacing between the planted contours. For spacings of 8 and 24 m the shrub survival increased from 90 to 94% at the 4% slope, and from 92 to 97% at a 6% slope.

On the northwest coast of Egypt, recent changes, such as the settling of the Bedouin population, have caused an increase in crop cultivation and development of orchards in wadi beds and depressions. These macro-catchment water-harvesting systems are fed by surface runoff from the degraded rangelands and rocky areas upstream. The average annual rain of 140 mm, which decreases quickly inland, is not sufficient to support cultivation without additional water resources.

Groundwater resources in the rangeland areas are often limited, difficult to access, and sometimes also of poor quality. Groundwater monitoring studies in northern Syria, in the low rainfall zones

(200-250 mm/yr) adjacent to the steppe, have indicated that during the last two decades the quantity and quality of the groundwater resources have been severely reduced. The main cause of this resource degradation is the use of diesel and electric-pumped wells for irrigation. In the Khanasser Valley, 70 km east of Aleppo, the large amounts of groundwater pumped for irrigation has induced saline water intrusion from the adjacent salt lake (Hoogeveen et al., 1999). Irrigation with this saline water has caused salinization of soils in the bottom of the valley. In Seyaleh, a village along the foothills of Jabal Al Hoss, southwest of Khanasser Valley, approximately 100 irrigation wells were drilled during the last two decades. Currently, almost 90% of these wells have fallen dry. Although a large number of farmers are now providing for their families through jobs in neighboring cities or countries, the remaining farmers are still irrigating barley, wheat, cotton, and some fruit trees and vegetables, using any water that they can extract from their wells. In the rangelands south of the valley, water is drawn by hand from shallow wells. The water is often salty. The wells are generally used only for watering livestock and for domestic tasks. Water for human consumption is brought in by tanker.

Qanats, traditional underground canal systems that guide groundwater by natural gravity flow to the surface, have been used as irrigation and drinking water sources for many centuries in the West Asia and North Africa region. These systems usually tap into bedrock or alluvial aquifers at the base of mountains or hills, but occasionally take their water from shallow aquifers adjacent to wadis. Qanats have been designed to give water year round, although flows may become less if water tables drop during dry periods. Many qanats in Syria are located in or along the borders of the steppe and served as the sole water source for the local population. Some of these qanats were partly restored by new settlers in the first half of the 20th century. Currently, the majority of the qanats have dried up completely and in others the flow is often reduced to a trickle. Although lack of maintenance affects the functioning of these ancient water systems, falling water tables due to the motorized pumping of groundwater wells is probably a more significant factor. In an inventory of 67 qanat sites throughout Syria, Lightfoot (1996) found that 210 of the 239 qanat galleries had dried up. Of these galleries 92% had stopped flowing since the mid 1970s, when pumped wells in Syria began to increase substantially. A research project at ICARDA successfully assisted a community with the renovation of their qanats (Wessels, 2000). ◆

Contacts:
M. Bounejmate, B. Norton, A. Gruggeman - ICARDA
P.O. Box 5466
Aleppo (Syria)
E-mail: nbounejmate@cgiar.org
bnorton@cgiar.org
agruggeman@cgiar.org

References

Al-Eisawi, M.H.D. 1998. Field Guide to wild flowers of Jordan and neighboring countries. Amman, Jordan

Alimayev, L.L. 2001. Changes in range condition in Kazakhstan since 1991. Paper presented at the ICARDA Workshop on Production of Cultivated Forages for Irrigated and Rainfed Areas, Bishkek, Kyrgyzstan, June 12-16, 2001

Al-Khawlani, M.A. and Mufarih, M. 2001. Impact of Tenure on Range Quality in Kohlan-Affar, Yemen. In Land degradation and rural livelihoods: Case studies in the WNANA region (Aden Aw-Hassan and Annie Cooper, eds.). ICARDA, Aleppo, Syria

Arab, G., T. Ngaido, T. Nordblom, G. Gintzburger, R. Tutwiler. 1998. Impact of cultivation, Human & Sheep Population on Syrian Rangelands: the Case Study of Jeb Al Jamaa Communities. Poster

Draz, O. 1980. Range and fodder crop development. Syrian Arab Republic, National Range Management and Fodder Crop Production Programme. AG:DP/SYR/011 Consultant Report. FAO, Rome

GCPE 1998. Jordan country study on biological diversity. The General Corporation for the Environment Protection. Amman, Jordan

Gintzburger, G. 1999. Range Roller Spirals to Steppe Seed Success. ICARDA CARAVAN No. 10 Winter/Spring 1999. ICARDA, Aleppo, Syria

Gintzburger, G., N. Battikha, E. Khoudari, A. Termanini, and N. Murad.1999. Protected and degraded *Artemisia* rangeland in Syria: seasonal biomass. Pages 333–334 *In:* Proceedings of the VI International Rangeland Congress, Volume 1. VI International Rangeland Congress, Inc., Australia

Gintzburger, T. L. Nordblom & A.E. Osman. 1997. Agro-pastoral systems, feed calendars and feed resources in the Arab countries of the mediterranean region. *In:* Proceedings of the Regional Symposium on Integrated Crop-Livestock Systems in the Dry Areas of West Asia and North Africa; 24–38 (Eds N. Haddad, R. Tutwiler, and E. Thomson). ICARDA, Aleppo, Syria

Hoogeveen, R, M. Zöbisch, and A. Bruggeman. 1999. *Water balance of the Khanasser Valley, Syria*. International Conference Water Resources Management, Use and Policy in Dry Areas, December 1- 3, 1999, Amman, Jordan

Jaubert , R., Debaine, F., Besancon, J., Al Dbyiat, M., Geyer, B., Gintzburger, G. and Traboulsi, M. 1999. The Arid Margins of Syria: Land use and vegetation cover; semi-arid and arid areas of Aleppo and Hama provinces (Syria). Cahiers de Recherche 1999. Groupe de Recherches et d'Etudes sur La Méditerrannée et le Moyen-Orient. Maison de l'Orient, Lyon, France

Le Houérou, H.N. 1991. Rangeland Management in Northern Africa and the Near East : Evolution, Trends and development outlook. Proceedings, Vth International Rangeland Congress, Montpellier, France. 544-553

Lightfoot, D.R. 1996. Syrian qanat Romani: history, ecology, abandonment. Journal of Arid Environments 33(3): 321-336

Mahdi, A.,Taha, S.D., Kasim, K.K. and Khtab, K.K.. 2001. Rangeland Degradation in Jabal Sinjar, Northern Iraq. In Land degradation and rural livelihoods: Case studies in the WNANA region (Aden Aw-Hassan and Annie Cooper, eds.). ICARDA, Aleppo, Syria

Mahyou, H., Tahri, M., Thomas, N. et Bounejmate, M. 2001. Etude de la dégradation des parcours de la commune rurale de Aïn Béni Mathar à l'aide des systèmes d'information géographiques et de la télédétection. Pages 43–49 *dans* compte rendu, atelier Gestion Durable des Ressources Agropastorales (Bounejmate M. et M. El Mourid, eds.), ICARDA/DDC/INRA, 20–22 février 2001, Oujda, Maroc. ICARDA, Alep, Syrie

Nordblom, T.L. and Shomo, F. 1993. Livestock and feed trends in West Asia and North Africa: past, present and future. Pages 15–30 *In* Vol. I: The Situation of Agriculture in Mediterranean Countries, No. 5, Agricultural Reaserch and Food Security. *Cahiers Options Méditerranéennes*. CIHEAM, Paris, France

Oweis, T., D. Prinz and A. Hachum. 2001. Water Harvesting; indigenous knowledge for the future of agriculture in the drier environments. ICARDA, Aleppo, Syria.

Sankary, N. 1993. Maintenance and development of rangeland in the Middle East countries. Pages 180-297 in "Maintenance and Development of the Rangeland, its Role in Combating Desertification in the Arab World". Proceedings of a workshop held in Amman, Jordan, 3-6 April 1993. FAO, Rome and Secretariat General Council of Arab Ministers Responsible for the Environment, Cairo

Shomo F., and Ngaido T. 2001. Rangeland and rising feed deficits in Central and West Asia /North Africa.. ICARDA, Aleppo, Syria

Wessels, J.I. 2000. Little Waterfall; Renovating Qanats in a Changing World, a Case Study in Syria. Paper presented at the International Symposium on Qanats, organised by UNESCO, Yazd, Iran, May 2000

Zöbisch, M., Masri Z. and Khatib, A. 1999. Natural Restoration Potential of Overgrazed Slopes in Dryland Northwestern Syria. Paper presented at the Sixth International Conference on the Development of Dry Lands, 22-27 August 1999, Cairo, Egypt