

Diversity Conservation of Rangeland and Forest Plant Species in Saudi Arabia

ABDULAZIZ M. ASSAEED

**Dept. of Plant Production, College of Agriculture, King Saud University,
P.O. Box 2460 Riyadh 11451 Saudi Arabia (e-mail: assaeed@ksu.edu.sa)**

ABSTRACT

Rangelands in Saudi Arabia extend over more than 175 m.ha. (about 75% of country land area) while woodland forests occupy only 2.7 m.ha. and are limited to the south western highlands. The diversity in landscape has been reflected in terrestrial plant species diversity. Range vegetation as well as forest understory vegetation has long history of grazing by livestock and wildlife herbivores. In recent decades however, major changes have occurred in vegetation composition and diversity because of some human activities of which over-grazing is a major factor. There are some evidences that current wildlife conservation practices are not supported by parallel emphases on vegetation. Failure of some conservation programs conducted by governmental agencies emphasizes the importance of controlled management of protected areas for the conservation of plant diversity. This paper briefly describes natural plant species diversity, introduces plant conservation practices in Saudi Arabian rangelands and forests, and evaluates the successes and failures of these practices to conserve biodiversity at the plant species level.

Key Words: conservation, plant diversity, plant communities, rangelands, forests, vegetation

INTRODUCTION

The Kingdom of Saudi Arabia with its 225,000 sq. kilometer area, occupies four fifths of the Arabian Peninsula. As a result of its geologic history, the country shares its flora with Africa in the west, Asia in the northeast, east and southeast and with the Mediterranean region in the northwest and the north. In global geographical term, the vegetation of Saudi Arabia in general has been referred to as belonging to the Arabian sub-zone of the Saharo-Sindian phytogeographical zone (Zohary 1973). However, the southwestern and most of the western coastal plains fall under the Somalia-Masai phytogeographical region (Chaudhary 1999).

The diverse physiographic features coupled with diverse climatic differences have resulted in remarkably diverse vegetation. Approximately 2243 native flowering plants have been recorded in Saudi Arabia (Al-Farhan 2000). Nearly 500 species are found in limited areas and about 656 exist in small populations. About 100 species have been listed as endangered or of vulnerable status (NCWCD 1998; Al-Farhan 2000). Despite the relatively extensive work, a complete picture of the flora of Saudi Arabia is far from complete. Al-Turki (2002) reported 47 newly recorded species of which 19 were endemics.

During the past five decades, extensive human activities (livestock grazing, fuel wood cutting and temporary arid land cultivation) have put great pressure on vegetation and lead to vegetation deterioration (Heady 1963, Batanouny 1991). The objective of this paper was to present and discuss the current managerial practices to conserve rangeland and forest plant diversity in Saudi Arabia.

CLIMATE AND VEGETATION

A hot weather generally characterizes the climate of Saudi Arabia for the greater part of the year to northerly winds moving from the eastern Mediterranean towards the Arabian



Figure 1. A satellite image of Saudi Arabia showing main topographic features.

Gulf. Relative humidity is low except along the coastal zones where it reaches over 90%. The average annual temperature is 33.4 °C in summer and 14 °C in winter, but there are wide variations. For example, inland temperatures range from below zero at night to a maximum of 50 °C during summer. In the northern part of Saudi Arabia, temperatures are very high in summer, the hottest month being July, while in south-east regions the hottest month is June and

the coldest is January (Juneidi, and Huss. 1978). Rainfall in the upper two-thirds of Saudi Arabia is scanty, unpredictable and irregular. Variations between years are high and long period may pass without rain. When rainfall occurs, it is very local and sometimes takes the form of violent storms of short duration. The intensity of the rainfall during such storms is far in excess of the capacity of the soil absorption. Thus the high rate of runoff

leads to rapid filling of wadi beds. Sometimes severe erosion and destruction may occur because of these floods.

The average annual rainfall in the northwestern part of Saudi Arabia varies from 30mm in the northern part to 90mm in the northeast. Rainfall records in the central part of Saudi Arabia, particularly in the Riyadh region, indicate that rainfall decreases from North to South and from west to East, averaging between 100 to 85 mm per annum. In general the mean annual rainfall averages less than 100 mm, most of it occurring in the period from December to March and serving substantially for the development of ephemeral vegetation (Juneidi, and Huss. 1978).

Rainfall conditions in the western and southwestern mountains are completely different and of two types- continental in winter and monsoon in summer. The rain is well distributed throughout the year with peaks in spring and fall. The annual rainfall exceeds 300 mm in the mountains averaging 250 mm along the Red Sea coast of Jeddah. Rainfall diminishes from Taif and Jeddah to the north towards Aqaba. Snow seldom falls in the mountains but hailstorms and winter frosts are common and the climate there is cool and dry.

Several investigators have described the vegetation in Saudi Arabia at different levels of details. To name few, these include the work of Vezy-Fetzgerald (1955, 1957ab), Batanouny (1979, 1987, 1991), Batanouny and Baeshin (1983) and Abulfatih (1992). Batanouny (1987) compiled the available information on vegetation in the Arabian Gulf countries. Table 1. shows some selected important plant communities in Saudi Arabia. Plant communities generally fall into one of three groups: i) communities dominated by grasses (5 communities), sedges (1 community), under-shrubs and trees (17 communities); ii) halophytic plant communities (9 communities) and iii) mountainous plant communities (5 communities). Due to the very diverse habitat, the presence of a plant community is generally governed by several factors such as geographical location, proximity to water bodies, rainfall regime, geological formations, soil characteristics and water resources (Batanouny 1987).

PLANT DIVERSITY CONSERVATION PRACTICES

In Saudi Arabia, the Ministry of Agriculture is in charge of rangeland and forest management. The major land uses in these two natural resources are grazing by livestock,

recreation and tourism. The National Commission for Wildlife Conservation and Development (NCWCD) runs a chain of 15 wildlife reserves comprising about 3% of the country land area where conservation of certain wildlife species has a major priority.

Table 1. A summary of some selected plant communities in Saudi Arabia (adopted from Batanouny 1987).

Plant Community	Habitat	Dominant Species
Desert Plant Communities (Grasses, Sedges, Under-shrubs and Trees)		
<i>Panicum turgidum</i>	Sandy soil	<i>Lasiurus scindicus</i> , <i>Pennisetum divisum</i> , <i>Calligonum comosum</i> , <i>Moltikiopsis ciliata</i> , <i>Astenatherum forskalei</i> , <i>Fagonia</i> spp., <i>Haloxylon salicornicum</i>
<i>Cyperus conglomeratus</i>	Aeolian sands	<i>M. ciliata</i> , <i>P. turgidum</i> , <i>C. comosum</i> , <i>Monsonia nirea</i>
<i>Rhanterium epapposum</i>	Sandy plains	<i>Achillea fragrantissima</i> , <i>Anvillea garcini</i> , <i>Helianthimum lippii</i>
<i>Artemisia herba-alba</i>	Gravelly plains and wadis	<i>H. salicornicum</i> , <i>A. fragrantissima</i> , <i>A. garcini</i> , <i>H. lippii</i>
<i>Acacia tortilis</i>	Wadis, gentle slopes, rocky and gravelly soils	<i>Lycium shawii</i> , <i>Acacia ehrenbergiana</i> , <i>P. turgidum</i>
Halophytic Plant Communities		
<i>Avicennia marina</i>	Saline flats along sea coasts	Pure <i>A. marina</i> population or with <i>Rhizophora mucronata</i>
<i>Aeluropus lagopoides</i>	Coastal and inland salt marshes	May form pure stands
Mountainous Plant Communities		
<i>Juniperus procera</i>	Above 1700 m altitude slopes	<i>Themeda triandra</i> , <i>Hyparrhenia hirta</i> , <i>Mentha longifolia</i>
<i>Acacia asak</i>	Between 1000-1500 m altitude on hillsides and plateaus	<i>Andropogon distachyus</i> , <i>Aristida coerulescens</i> , <i>Stipagrostis obtusa</i> , <i>Cenchrus ciliaris</i>

Since the abandonment of the 'hema' system in 1953, yearlong continuous grazing by livestock became the dominant practice applied in rangelands and the understory of forest vegetation in Saudi Arabia. The Ministry of Agriculture has conducted several revegetation projects and established several exclosures of different sizes for various purposes. Several depressions (Raudhat) are also fenced to prevent vehicle traffic but allow animal passage to graze. These practices are evaluated below along with the hema system in relation to conservation of plant diversity.

Complete Protection

Most of the protected exclosures are situated in the northern region of the country where grazing by livestock is the dominant land use. Table 2 presents results of studies on vegetation response to complete protection. Only one study (Shaltout et al. 1996) was intended to examine the effect of protection from grazing on plant diversity. The vegetation, comprised of halophytes, responded positively to 14 years of protection by an increase in both species richness and evenness. It was not possible to calculate diversity indices for other studies. However, despite the short duration of such studies (2-3 years), 9 out of 13 cases indicated a positive response to complete protection. Heemstra and Al-Hassan (1990) cautioned that increase in density of perennial species could be a temporary one due to a decrease in seedling survival caused by prolonged drought in several sites.

Several authors indicated that both uncontrolled grazing and complete protection from grazing have deleterious effects on vegetation (Thalen 1979, Shaltout and El-Ghareeb 1985). Overgrazing would likely to reduce plant diversity through differential plant selectivity by grazing livestock. When overgrazing pressure continues, palatable perennial species will be replaced by unpalatable annuals or even poisonous plants such as *Rhazya stricta* (Assaeed 1996). Similarly, complete protection from grazing have been found decrease plant diversity in the northern Saudi Arabia due dominance of some unpalatable annuals such as *Artemisia scoparia* (Heemstra and Al-Hassan 1990). Thalen (1979) argued that moderate grazing might be necessary to maintain productivity of rangelands through maintenance of vegetation diversity.

Partial Protection

Under this type of practice, grazing in certain range sites, having important value such as depressions (= *Raudhat*), is deferred until the seed setting of annuals is complete in rainy years. However, grazing is permitted for the rest of the year. Usually these sites are fenced with metallic posts to prevent vehicle traffic but allow livestock access. Partial protection, as currently implemented, favors annuals over perennials as the first group are allowed to set seeds while the second group suffers from grazing for most of the year especially in years of low rainfall. Indeed, Alfarhan (2001) reported that Raudhat Khuraim (a 24 km² depression, 90 km northeast of Riyadh city) hosts 152 vascular plant species of which 82% are annuals. Such a practice if continued may lead to an irreversible situation if soil seed bank resources are exploited. Assaeed and Al-Doss (2002) evaluated the soil seed bank in one of the partially protected sites and concluded that most of the desirable perennial species are disappearing. Partial protection could be very effective way of conservation if grazing is regulated as evidenced from other arid and semi-arid regions (Singer 1996, Milton et al. 1997).

Hema System

Hema is a traditional system of grazing management whereby grazing is allowed in certain range reserves at moderate stocking rate during drought. It was a widespread practice in the Arabian Peninsula especially in the southwestern region. Draz (1978) described hema system in details. Draz (1969) noticed successful recruitment of some valuable grasses such as *Themeda triandra* through the adoption of hema system in the southwestern region. Despite the Royal Decree in 1953 to abandon the hema system, several hema reserves still exist. Hema Beni Sarr in the mountainous city of Belgurashi and hema Alghadha, near Unaizah city in central Saudi Arabia, are examples of range reserves that are still maintained in good conditions. The first is used for forage reserves in summer while the later is maintained for sand dune stabilization through protection of the native shrub *Haloxylon persicum* against fuel cutting. In both reserve plant diversity is maintained in a relatively good conditions. Revival of hema system as postulated by Draz (1978) could be an efficient practice to conserve species diversity.

Table 2. A summary of some selected studies on the response of vegetation to protection from grazing.

Vegetation Type	Geographical Location	Years of Protection	Response	Reference
Coastal lowlands	Al-Hassa, E. Region	14	33% increase in species richness and 32% increase in relative species evenness	Shaltout et al 1996
Desert shrubs	Wadi Tamriat, N. Region	3	An increase in density of <i>Salsola villosa</i> , <i>Anabasis setifera</i> and <i>Atriplex leuoclada</i> with a decrease in density of <i>Achillea fragrantissima</i>	Mirreh and Al-Diraan 1986
<i>Rhanterium epapposum</i> dwarf-shrub	Sakaka, N. Region	3	An increase in density, frequency and cover of <i>Stipagrostis drarii</i> and <i>Gypsophylla arabica</i>	Heemstra and Al-Hassan 1990
<i>Calligonum comosum</i> - <i>Scrophularia hypericifolia</i> shrublands	Aathiia, N. Region	2	No significant changes were detected	Heemstra and Al-Hassan 1990
<i>Haloxylon salicornicum</i> - <i>Traganum nudatum</i> open dwarf-shrub	Marot, N. Region	2	No significant changes were detected	Heemstra and Al-Hassan 1990
<i>Haloxylon persicum</i> shrub	Marot, N. Region	3	An increase in density of <i>S. drarii</i>	Heemstra and Al-Hassan 1990

Table 2. Continued.

Vegetation Type	Geographical Location	Years of Protection	Response	Reference
<i>Salsola villosa</i> - <i>Artemisia herba-alba</i> dwarf-shrub	Tamriat, N. Region	3	An increase in density of <i>S. villosa</i>	Heemstra and Al-Hassan 1990
<i>Artemisia herba-alba</i> – <i>Achillea</i> <i>fragrantissima</i> dwarf- shrub	Wadi Mayaala, N. Region	3	No significant changes were detected	Heemstra and Al-Hassan 1990
<i>Atriplex halimus</i> – <i>Salsola tetrandra</i> saltbush shrubs	Meisari, N. Region	3	An increase in cover of <i>Limonium</i> sp., <i>S. tetrandra</i> and <i>Alhagi graecorum</i>	Heemstra and Al-Hassan 1990
Mixed dwarf-shrub	Buseita, N. Region	3	A decrease in density of <i>Pulicaria</i> <i>crispa</i> and <i>Zilla spinosa</i>	Heemstra and Al-Hassan 1990
<i>Haloxylon persicum</i> – <i>H. salicornicum</i> shrubland	Wadi Ma'arik, N. Region	3	A decrease in cover of both species but no compositional changes occurred inside the enclosure	Heemstra and Al-Hassan 1990
Woodland	Abha, S.W. Region	5	267% increase in phytomass	Abulfatih et. al 1989
Woodland	Khamis Mushait, S.W. Region	'Hema'	114% increase in cover	Zahran and Younes 1990

Revegetation

Rangeland revegetation may not be economically feasible in arid areas (Heady 1963). When conducting revegetation as a tool for diversity restoration, certain ecological aspects have to be considered to maintain sound plant diversity (e.g. Brown and Amacher, 1999, Jones 2003).

Several vegetation projects using introduced species did not succeed (Mirreh and Al Daraan 1988). However, there are also successful ones such as sand-dune stabilization project in Al-Hasa oasis where both introduced and native trees and shrubs were used (Abohassan and Rudolph 1978). *Avicennia marina* was one of the few species that received attention from NCWDC both in the Red Sea and The Gulf coastal shores (Böer 1994). Planting *A. marina* in the Arabian gulf seashore was relatively successful and may enhance both marine and terrestrial species diversity (Böer 1996).

Revegetation by native plant species has been used successfully to restore diversity in other parts of the world (e.g. Aronson et. al 1993). However, under the harsh environmental conditions of Saudi Arabia, more research work is needed before considering revegetation as a tool for conservation of some species that are under heavy pressure of grazing such as *Sasola villosa*, *Panicum turgidum* and *Atriplex* spp.

REFERENCES

- Abohassan, A.A. and V.J. Rudolph. 1978. Afforestation for sand dune stabilization in Al Hassa Oasis, Saudi Arabia. pp. 257-259. In D.N. Hyder (ed.). Proceedings of the first international rangeland congress. Denver, USA.
- Abulfatih, H.A. 1992. Vegetation zonation along an altitudinal gradient between sea level and 3000 meters in southwestern Saudi Arabia.
- Abulfatih, H.A., H.A. Emara and A. El-Hashish 1989. Influence of grazing on vegetation and soil of Asir highlands in south western Saudi Arabia. Arab Gulf J. Sci. Res. 7:69-78.
- Al-Farhan, A.H. 2000. An evaluation of the current status of the flora of Saudi Arabia. Country report presented at the 2nd Arabian Plants Subject Group Meeting, Abudhabi, May 2000. (Draft paper).

- Al-Farhan, A.H. 2001. A floristic account on Raudhat Khuraim, central province, Saudi Arabia. *Saudi J. Biol. Sci.* 8: 80-103.
- Al-Turki, T.A. 2002. An initiative in exploration and management of plant genetic diversity in Saudi Arabia. pp. 339-349. In: J.M. Engels, V.R. Rao, A.H. Brown and M. T. Jackson (eds.) *Managing plant genetic diversity*. CAB International, Wallingford, UK.
- Aronson, J., C. Floret, E. Le Floch, C. Ovalle, and R. Pontanier. 1993. Restoration and rehabilitation of degraded ecosystems in arid and semi-arid lands. II. Case studies in southern Tunisia, central Chile and northern Cameroon. *Restoration Ecology* 1:168-187
- Assaeed, A.M. 1996. *Hammada elegans-Rhazya stricta* competitive relationships in a deteriorated range site in Raudhat Al-khafs, Saudi Arabia. *J. Agric. Sci. Mansoura Univ.* 21: 957-964
- Assaeed, A.M. and A.A. Al-Doss 2002. Soil seed bank of a desert range site infested with *Rhazya stricta* in Raudhat al-Khafs, Saudi Arabia. *Arid Land Res. & Manage.* 16:83-95.
- Batanouny, K.H. 1979. Vegetation along the Jeddah-Mecca road: pattern and process as affected by human impact. *J. Arid Environ.* 2:21-30.
- Batanouny, K.H. 1987. Current knowledge of plant ecology in the Arab Gulf countries. *Catena* 14:291-316.
- Batanouny, K.H. 1991. Vegetation of the Summan (Arabia): Pattern and process as affected by human impact and modern technology. IVth. International Rangeland Congress, Montpellier, France. 4: 310-314.
- Batanouny, K.H. and N.A. Baeshin 1983. Plant communities along the Medina- Badr road across the Hejaz mountains, Saudi Arabia. *Vegetation* 53:33-43.
- Brown, R.W., and M.C. Amacher. 1999. Selecting plant species for ecological restoration: a perspective for land managers. pp. 1-16. In: L.K. Holzworth and R.W. Brown (eds.) *Revegetation with native species*. Proceedings, 1997 Society for Ecological Restoration annual meeting. 12-15 Nov., 1997. Ft. Lauderdale, FL. RMRS-P-8. USDA-FS Rocky Mountain Research Station, Ft. Collins, CO.
- Böer, B. 1994. Status and recovery of the intertidal vegetation after the 1991 gulf war oil spill. *Courier Forschungsinstitut Senckenberg* 166:22-26.
- Böer, B. 1996. Trial planting of mangroves (*Avicennia marina*) and salt-marsh plants (*Salicornia europaea*) in oil impacted soil in the Jubail area, Saudi Arabia. pp. 186-192. In: F. Krupp, A.H. Abuzinada and I.A. Nader (eds.). *A marine wildlife sanctuary for the Arabian Gulf*. Environmental research and conservation following the 1991 gulf war oil spill. NCWCD, Riyadh and Senckenberg Research Institute, Frankfurt aM.
- Chaudhary, S.A. (ed.) 1999. *Flora of the Kingdom of Saudi Arabia* (vol. 1). Ministry of Agriculture and Water. Riyadh.

- Draz, O. 1969. The "Hema" system of range reserves in the Arabian Peninsula, its possibilities in range improvement and conservation projects in the East. FAO/PL: PFC/13.
- Draz, O. 1978. Revival of the hema system of range reserves as basis for the Syrian range improvement program. pp. 100-103. In D.N. Hyder (ed.). Proceedings of the first international rangeland congress. Denver, USA.
- Heady, H.F. 1963. Grazing resources and problems. A report to the Government of Saudi Arabia. FAO., Rep. No.1614, Rome.
- Heemstra, H.H. and H.O. Al-Hassan 1990. Range monitoring in northern Saudi Arabia (1984-1987). Ministry of Agriculture and Water. Riyadh . Saudi Arabia. p.160.
- Jones, T. A. 2003. The Restoration Gene Pool Concept: Beyond the Native Versus Non-Native Debate. *Restoration Ecology* 11 (3), 281-290.
- Juneidi, M. and D.L. Huss. 1978. Rangeland resources of the Gulf and Arabian Peninsula countries and their managerial problems and needs. FAO, RNEA, Cairo, Egypt.
- Mirreh, M.M. and M.S. Al-Diraan. 1986. The effect of three year's protection on the vegetation of Wadi Tamriat. Range and Animal Development Research Center. Working Paper No. TW-2., p.6. (Unpublished).
- Mirreh, M.M. and M.S. Al-Diraan. 1988. Response of exotic and indigenous species under rainfed in wadi Mayaala of northern Saudi Arabia. Range and Animal Development Research Center. UTFN/SAU/008/SAU, Al Jouf. p.14. (Unpublished).
- Milton S.J., Yeaton R.I., Dean W.R.J. & Vlok J.H.J. 1997 Succulent Karoo. In R.M. Cowling, D.M. Richardson & S.M. Pierce (Eds) *Vegetation of Southern Africa*. Pp. 131-166. Cambridge University Press, Cambridge.
- NCWCD 1998. Species status and conservation strategy. B. Endangered, vulnerable and rare plant taxa in the Kingdom of Saudi Arabia. National Commission for Wildlife Conservation and Development. Riyadh.
- Shaltout, K.H. and R. El-Ghareeb 1985. Effect of protection on the phytomass and primary production of ecosystems of the western Mediterranean desert of Egypt. I. Ecosystem of non-saline depressions. *Bull. Fac. Sci. Alexandria Univ.* 25:109-131.
- Shaltout, K.H., E.F. El-Halawany and H.F. El-Kady. 1996. Consequences of protection from grazing on diversity and abundance of the coastal lowland vegetation in eastern Saudi Arabia. *Biodiversity and Conservation*. 5: 27-36.
- Singer, F.J. 1996. Effects of grazing by ungulates on upland bunchgrass communities of the northern winter range of Yellowstone National Park. pp 127-138 in F.J. Singer, (ed.). *Effects of grazing by wild ungulates in Yellowstone National Park*. Technical Report NPS/NRYELL/NRTR/96-01, NPS, Natural Resource Information Division, Denver.
- Thalen, D.C.P. 1979. Ecology and utilization of desert shrub and rangeland in Iraq. *Junk Publ. The Hague*. p. 428.

- Vesey-Fitzgerald, D.F. 1955. Vegetation of the Red Sea coast south of Jeddah, Saudi Arabia. *J. Ecol.* 43: 477-489.
- Vesey-Fitzgerald, D.F. 1957a. The vegetation of the Red Sea coast north of Jeddah, Saudi Arabia. *J. Ecol.* 45: 547-562.
- Vesey-Fitzgerald, D.F. 1957b. The vegetation of central and eastern Arabia. *J. Ecol.* 45:779-793.
- Zahran, M.A. and H.A. Younes 1990. Hema system: traditional conservation of plant life in Saudi Arabia. *J.K.A.U. Sci.* 2:19-41.
- Zohary, M.1973. *Geobotanical foundation of the Middle East.* (2 vols.) Gutav Fischer Verlag. Stuttgart, Germany.