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Vegetation and condition of arid rangeland ecosystem in Central Saudi Arabia



S.R. Al-Rowaily^{a,*}, A.M. Assaeed^a, S.A. Al-Khateeb^b, A.A. Al-Qarawi^a,
F.S. Al Arifi^c

^a Plant Production Dept., College of Food & Agric. Sciences, King Saud University, Saudi Arabia

^b Dept. Environ. & Nat. Agric. Res., College of Agric. & Food Sciences, KFU, Saudi Arabia

^c Space Research Institute, KACST, Saudi Arabia

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Abstract Saudi Arabia rangeland ecosystems have undergone intense processes of degradation for many decades because of extreme climate and human activities such as overgrazing and socioeconomic changes. In this study, Hail and Qassim Regions of Saudi Arabia covering an area about 79610.73 km² were selected to study the rangeland vegetation and condition. *Haloxylon salicornicum* was the most dominant species, covering more than 56% of the total area. The second prominent community was *Acacia-Lycium shawii*, which covers about 21% of total area. It was found that about 65% of vegetation in the surveyed area is in good or very good condition compared with about 31% in poor or deteriorated condition. Effective measures such as determination of carrying capacities and development of grazing systems have to be implemented to ensure resources sustainably.

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1. Introduction

Saudi Arabia occupies about 80 percent of the Peninsula (Abd El Rahman, 1986). In general, most of the country can be classified as an arid land ecosystem characterized by unpredictable and low-erratic precipitation and high temperatures (Shmida,

1985). High rainfall variability is the norm between and within years. Mean annual temperature of Saudi Arabia is about 20 °C (De Pauw, 2002). Rangelands of Saudi Arabia occur mainly in arid and hyper-arid regions that cover about 75% of the country (Al-Rowaily, 1999). These rangelands differ functionally because of differences in the spatial and temporal distribution of vegetation structure, soil and climate of each region. (Chaudhary and Le Houérou, 2006). Livestock grazing (mainly sheep, camels, and goats) is the prevalent form of land use in rangelands (Al-Rowaily, 1999, 2003). Despite the relatively low productivity, rangeland ecosystems benefits derived from them are becoming increasingly recognized. These include watershed management (Al-Saud, 2009), wildlife conservation (Abuzinada, 2003) and eco-tourism (Seddon, 2000).

* Corresponding author.

E-mail address: srowaily@ksu.edu.sa (S.R. Al-Rowaily).

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In the interior of Saudi Arabia, there were relatively very rich stands of communities of *Haloxylon salicornicum* and *Rhanterium epapposum*. The same areas now support dense stands of unpalatable shrubs or herbs such *Rhazya stricta*, *Pulicaria undulata* and *Astragalus spinosus* (Chaudhary and Le Hou rou, 2006). Acacia woodlands cover extensive patches of wadi runnels and localized plain areas. The major species are the *Acacia tortilis*, *Acacia ehrenbergiana* and *Leptadenia pyrotechnica*. Woodland understory host several species of low shrubs, grasses, and annual and perennial herbs. This vegetation complex forms the major rangelands resources for livestock (Chaudhary and Le Hou rou, 2006; Ghazanfar and Fisher, 2013).

Relatively low productivity per unit area with a high proportion of bare ground is a characteristic of these fragile rangelands. For example, Bayoumi (1986) estimated that 260 ha of rangelands are required per annum to support one camel. Earlier, Kingery (1971) had estimated that over two thirds of rangelands of Saudi Arabia had been destroyed by overgrazing and tree and shrub cutting for. By 1985, it was estimated that 75% of the whole country was seriously degraded due to destruction of the natural vegetation (Anon, 1985). Rapid social and economic changes during the past few decades, led to heavy and prolonged pressure on rangeland ecosystems. Overgrazing, fuelwood cutting and cultivation pressure brought intense processes of environmental degradation to nearly all of the rangelands in Saudi Arabia (Heady, 1963; Batanouny, 1991; Al-Rowaily, 2003; Chaudhary, 2010; Dregne, 2002; El-Keblawy et al., 2009). Increased human activity tends to over-stress land and vegetation which has increased steadily across the entire Arabian Peninsula leading to resources degradation, salinization, and erosion (Kingery, 1971; Khan, 1982; Hellden, 1991; Oatham et al., 1995; Ghazanfar, 2003; Kharbotly et al., 2003; Geist and Lambin,

2004). The result has been a drastic reduction of species diversity, density, composition and reduction of plant cover (Barth, 1999; Al-Rowaily, 1999). Several works describing the natural vegetation of Saudi Arabia are published (e.g. Miller and Cope, 1996; K rschner, 1998; El-Ghanim et al., 2010; Watts and Al-Nafie, 2013). However, most of these studies were more generalized and lack details. The current study aimed to describe vegetation and assess the current condition of rangelands at Hail-Qassim region in Central Saudi Arabia.

2. Materials and methods

Natural vegetation in Hail and Qassim regions of Saudi Arabia was studied covering a total area of about 79610.73 km². The area is located between 44° 30'–48° E and 24° 15'–28° 45' N (Fig. 1). The two regions are characterized by several landscape units, such as isolated mountains (e.g. Aja, Salma,

Table 1 Area of vegetation communities in Hail and Qassim Regions of Saudi Arabia and% from total surveyed area.

Vegetation Communities	Area (km ²)	% of total area
<i>Haloxylon salicornicum</i>	47453.00	59.6
<i>Acacia-Lycium shawii</i>	17156.48	21.6
<i>Haloxylon salicornicum-Lycium shawii</i>	7973.98	10
<i>Suaeda vermiculata</i>	2561.75	3.2
<i>Haloxylon salicornicum-Panicum turgidum</i>	2445.57	3.1
<i>Rhanterium epapposum</i>	1147.94	1.4
<i>Haloxylon salicornicum-Zilla spinosa</i>	872.01	1.1

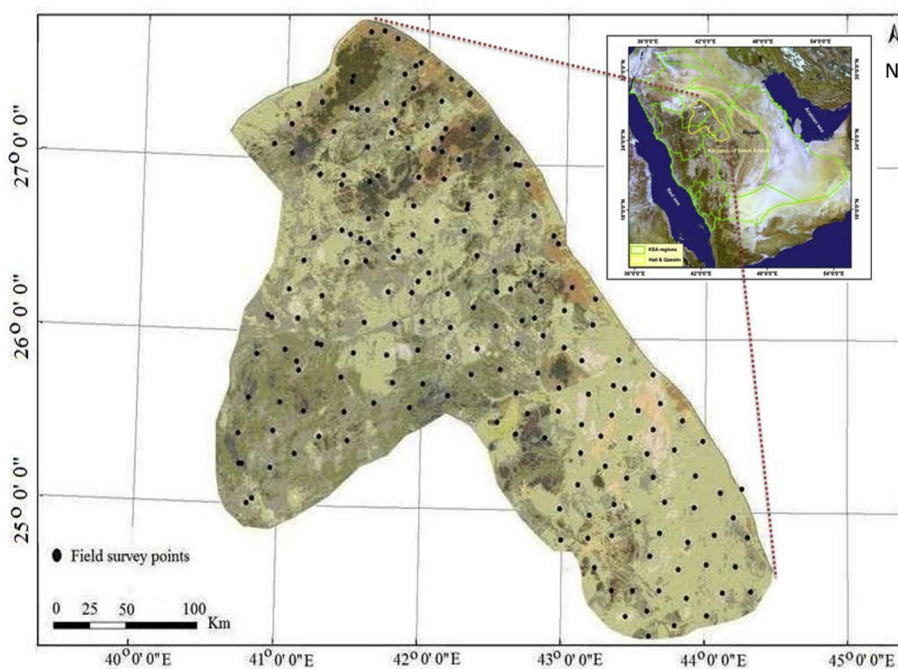


Figure 1 Study area with field distribution of vegetation stands.

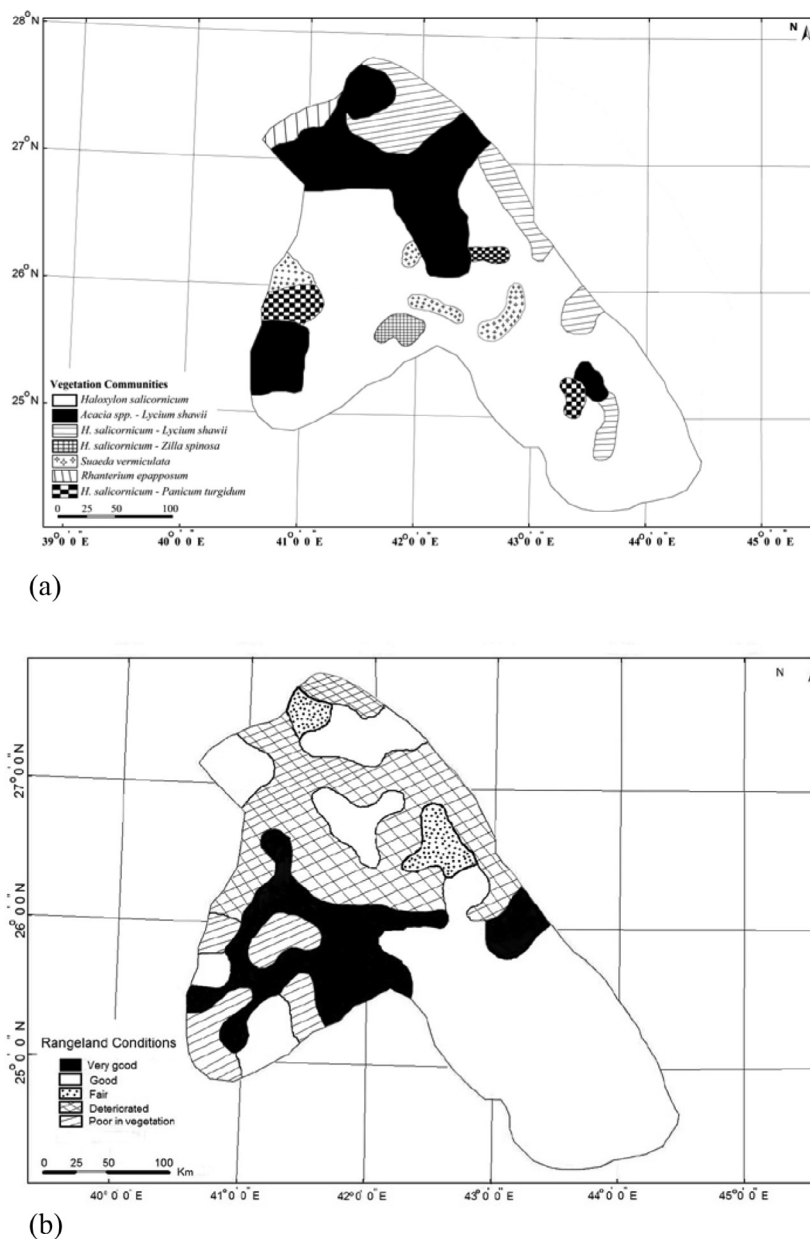


Figure 2 The main vegetation communities (a) and rangeland conditions (b) of Hail-Qassim area.

Table 2 Area of Hail and Qassim rangeland conditions and% from total area.

Range condition	Area (km ²)	% of total area
Very good	13492.75	17
Good	38404.78	48
Fair	2796.37	3.5
Poor	5457.56	7
Deteriorated	19459.27	24.5

Abanat) plains, escarpments, wadis and sand dunes (Chapman, 1978).

For rangeland assessment, SPOT 2 and 4 satellite imageries produced in 2004 were used. These images were utilized for initial reconnaissance and later to produce vegetation maps. Sam-

pling sites were selected (to not more than 20 km a part) and stratified to accommodate heterogeneity of small microhabitats of the landscape. A total of 207 stands was selected in a relatively homogeneous area in terms of topography, and vegetation. Three transects placed in each stand measuring 100 m long where five quadrates (5 m × 5 m) systematically placed at 20 m intervals along the transect lines, 25 m² each, with a total of 15 subplots in each stand.

Data recorded in each site included topography, soil erosion, plant species, and type of grazing animals. In addition, vegetation attributes were estimated in each quadrate included percent species cover, density and frequency (Bonham, 1989). Vegetation cover percentage was given a value using the Domin cover scales (Kent and Coker, 1992). The main dominant communities in each site were inferred from the calculated importance values. Importance value for perennial

plants were calculated by summing up relative density, relative percent cover and relative frequency. Finally, rangeland condition was classified and given scale according to the method of Soil Conservation Service (now Natural Resources Conservation Service) as described by to Holechek et al. (1998). This method combines some features of both soil and vegetation attributes along a continuum of classes from excellent to deteriorated condition (Pieper and Beck, 1990).

3. Results and discussion

Haloxylon salicornicum is the most recurrent species and vegetation community which was found in over a large area (Table 1). This community was distributed all-over the surveyed area except the northern part (Fig. 2). It is not unexpected to note that *H. salicornicum* occupies such a large area as Watts and Al-Nafie (2013) stated that it is extensively distributed in several habitats throughout the deserts of Saudi Arabia. Further, having low palatability to livestock and broad ecological niches, *H. salicornicum* would have an advantage over other palatable species due to the reduced competition for water and nutrients (Belgacem and Louhaichi, 2013). The second prominent community was *Acacia-Lycium shawii* community (Fig. 2, Table 1). It is dominated by *A. ehrenbergiana*, *A. tortilis* and *A. gerrardii*. This community was distributed in wadis mostly in the northern part of the surveyed area (Fig. 2). The rest of the identified plant communities accounted for only 8.8% of the total surveyed area (Table 1).

The palatable species were recorded in very low cover and density in small none reprehensive sites included such as *Ziziphus nummularia*, *Stipagrostis plumosa*, *Salsola cyclophylla*, *Noaea mucronata*, *Seidlitzia rosmarinus*, *Suaeda vermiculata*, *Sasola tetrandra*, and *Atriplex leucoclada* (data are not shown). In addition, less palatable species such as *Haplophyllum tuberculatum*, *Fagonia bruguieri*, *Achillea fragrantissima*, *Teucrium polium* and *Astragalus spinosus* were also recorded.

It was found that about 65% of the area surveyed is in good or very good condition. On the other hand, about 31% of the region under consideration was classified as in poor or deteriorated condition (Fig. 2, Table 2). These findings are comparable with those reported by other researchers (Abo-Hassan, 1981; Al-Rowaily et al., 2008).

4. Conclusions

Saudi Arabia rangeland ecosystems have undergone intense degradation for the last few decades. Overgrazing is a common feature of Hail-Qassim rangeland. Field assessment and remote sensing analyses showed evidence of severity of rangeland ecosystem degradation. One third of the rangeland steppe is considered moderately to severely degraded. Socioeconomic and sociocultural constrains are part of factors hindering rehabilitation success. However, effective measures have to be implemented to ensure resources sustainably and restoring disturbed rangeland in these two regions. Ensuring environmental sustainability in Saudi Arabia represents a challenge for a balance between human needs and economic growth. Measures should include an interdisciplinary approach such as determination of carrying capacities and development of grazing systems socially acceptable to livestock herders with coordination among various government agencies.

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