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PHYTOSOCIOLOGICAL STUDIES OF SELECTED SEMI-ARID SITES IN AL-MAFRAQ, JORDAN

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ABSTRACT

Two sites, one north facing and another south facing slope, were selected randomly outside Surra Rangeland Reserve in Al-Mafraq governorate of northern Jordan. The two sites belong to Irano-Turanian region and support steppe rangeland vegetation.Thirty six quadrats, each of one square meter were surveyed for each site. Vegetation total cover, dry biomass, and total number of individuals at species and family levels were recorded in each quadrat and averaged per site. Species richness, relative frequency, relative density and importance values were subsequently calculated. Marked difference in species diversity and composition was observed between the two sites. The south-facing site supported lower species richness and fewer plant families. *Stipa sp* was the most important species in south facing site while *Poa bulbosa* in north facing. The two sites shared general characteristics of disturbed steppe rangeland, including low productivity and diversity, and both sites dominated by Poaceae and Chenopodiaceae (notably *Salsola vermiculata*).

Key words: Herbaceous vegetation cover, Jordan, Steppe vegetation, Irano-Turanian region, Rangelands.

INTRODUCTION

Jordan's plant ecology is largelya product of four major factors: topography and altitude; rainfall; temperature; and soil type (Eig 1946; Al-Eisawi 1985, 1997; Anonymous 2000a, b). Moreover, its location, climate and geological formations (Anonymous 2000a) give the country distinctive ecological features of regional and global significance.Thirteen vegetation types within four biogeographical regions are recognized in Jordan (Long 1957; Al-Eisawi 1985).

Most of the area of Al-Mafraq governorate of northern Jordan falls within the arid or semi-arid zones of Mediterranean climate (less than 200 mm rainfall) and is characterized by low vegetation productivity (Le Houerou 1992; Juneidi and Abu-Zanat 1993; Abu-Zanat 1995; Al-Shawaheneh *et al*. 1998; Abu-Zanat *et al*. 2003, 2004; Al-Tabini *et al.* 2012; Damhoureyeh 2017). Moreover, most of the area is degraded rangeland that is severely affected by overgrazing, plowing, removal of woody plants and the cultivation of barley for fodder. The Jordanian rangelands constitute marginal steppe ecosystem of low primary productivity (Abu-Zanat *et al*. 2004; Damhoureyeh 2017). To protect this fragile ecosystem from overgrazing, overstocking, plantation of fodder, and removal of woody plants (Le Houerou 1992; Juneidi and Abu-Zanat 1993; Abu-Zanat 1995; Al-Shawaheneh *et al*. 1998; Abu-Zanat *et al*. 2003; Al-Tabini *et al.*2012), the Jordanian Ministry of Agriculture established many rangeland reserves. One such reserve is Surra Rangeland Reserve (Fig 1) in which, the ministry conducted a rehabilitation program of re-vegetation with fodder shrubs instead of barley and other measures to improve secondary productivity and sustainability (Le Houerou 1992; Juneidi and Abu-Zanat 1993; Abu-Zanat 1995; Al-Shawaheneh *et al*. 1998; Abu-Zanat *et al*. 2003; Al-Tabini *et al.* 2012).

Most studies of plant communities' species composition and habitats in Jordan have been largely descriptive (Poore and Robertson 1964; Kurschner 1986; Al-Eisawi 1982, 1985, 1997), with a few studies attempting to quantify analysis of vegetation composition (Al-Bakriand Abu-Zanat 2007; Al-Bakri *et al.* 2011; Damhoureyeh 2007, 2017). Damhoureyeh (2017) presented a population study for *Salsola vermiculata* within the confines of Surra Reserve. The study presented in this paper is a complimentary follow-up vegetation analysis of the area outside Surra Reserve, with the explicit aim of quantitatively analyzing the herbaceous vegetation composition, distribution and abundance of unprotected marginal steppe rangelands.

METHODOLOGY

Site selection and description: Two sites within Al-Mafraq area, outside Surra range land reserve (36°10'E 32° 14'N), were selected randomly for this study and sampled during the spring of 2017. Both the sites belonged to Irano-Turanian region, which contain steppe vegetation and were comparable for the relevant ecological variables, except for the fact than one site was north and the other was south facing. South-facing slope get greater solar radiation and as such tend to be generally warmer and drier. All other variables are equal (Albaba 2014).

Experimnetal design: Herbaceous vegetation was sampled using the line transect technique (Hunt 1978; Barbour *etal*. 1987). At each site, six sixty-meter long line transects were laid. A long each transect, six one-square-meter quadrat were surveyed, 36quadrats per site. The averaged parameters of dry biomass, total cover of herbaceous vegetation, and total number of individuals of each species, and corresponding family were recorded.

Relative density (RD), relative frequency (RF) at species, and family levels were calculated and the importance value (IV) index (0-200) was subsequently calculated as product of RD and RF of each species (Bray and Curtis 1957; Ayyad and Dix 1964; Barbour *et al.* 1987; Krebs 1989; Hegazy *et al.* 1998) and for each family (Pascal 1988; Manohar 2015).

The density of each species was recorded as number of individuals per quadrat and the relative density was calculated using the formula

Relative Density (RD) = species density / Total densities for all species

The frequency that is quadrats of occurrence over all quadrat studied for each species and the relative frequency was calculated using the formula

Relative Frequency (RF) = species frequency / Total frequencies for all species

Importance Value (IV) Index was calculated by adding RF and RD for each species, then the family IV was calculated by adding IV index for different species of the same family (Pascal, 1988; Manohar, 2015).

RESULTS

The overall visual inspection showed a degraded and overgrazed area, as is the case in general for rangeland all over Jordan (Al-Bakri and Abu-Zanat 2007).

As shown in Table 1, north-facing slope site has less average vegetation cover (28%) and dry biomass (57 gm) per meter squarethan the south-facing site (42% and 97gm, respectively).Table 2 shows that the vegetation of north-facing site belongs to 27 species, 24 of which are herbaceous. The most important plant species in the north-facing site is *Poa bulbosa* (IV = 86.51) followed by *Avena sp* (IV = 26.14) (herbaceous). Plant species of north-facing site belong to 14 families (Table 3). Fifteen plant species (10 herbaceous) (Table 4) of south-facing slopes that belongs to seven plant families (Table 5). The most important of which are *Stipa sp* (IV = 130.25) and *P. bulbosa* (IV = 26.58) (herbaceous). Not surprisingly, the south-facing slope have lower plant species that belong to fewer plant families. Both the sites, *S. vermiculata* is the most import ant shrub species (IV = 16.76 and 9.20 in north- and south-facing sites, respectively) and has the third highest IV (Tables 2 and 4).

As shown in Table 2, in the north-facing site *P. bulbosa* then *Avena sp* (herbaceous), while the shrub *S. vermiculata* has the third highest IV index. In the south-facing site, *Stipa sp* then *P. bulbusa* (herbaceous) followed by *S. vermiculata* (Table 4).

Table 3 and 5 demonstrate that most of the plants belong to Poaceae and Chenopodiaceae. They have the highest relative frequencies and densities. Overall, Poaceae is the most important family in both sites, while Chenopodiaceae is the most important family of shrubs, ranked second.

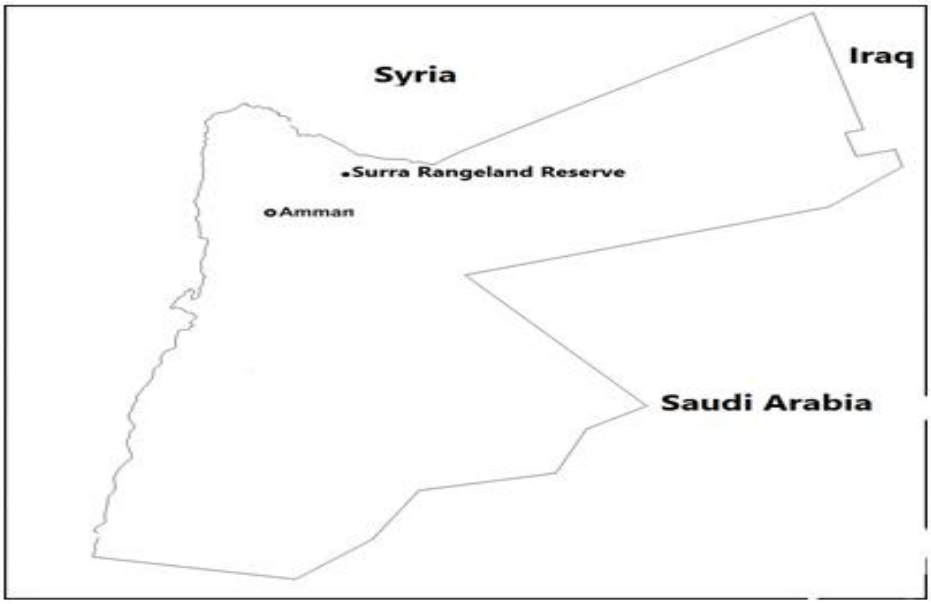

Fig. 1. The Hashemite Kingdom of Jordan, Surra Rangeland Reserve.

Table 1. Vegetation cover and dry biomass of the study area.

Variable	North-Facing Slopes	South-Facing Slopes
Average Vegetation Cover (%)	28	42
Average Dry Biomass (gm/quadrat)	57	97

Table 2. Relative Frequency (RF), Relative Density (RD) and Importance Values (IV) and form of Vegetation of North Facing site.

Number	Species	Form	Family	RF	RD	IV (0-200)
1	*Poa bulbosa*	Herb	Poaceae	18.12	68.39	86.51
2	*Avena sp*	Herb	Poaceae	7.14	19.01	26.14
3	*Salsola vermiculata*	Shrub	Chenopodiaceae	15.37	1.39	16.76
4	*Allium sp*	Herb	Liliaceae	13.18	2.34	15.52
5	*Silene sp*	Herb	Caryophyllaceae	8.78	3.93	12.71
6	*Lolium sp*	Herb	Poaceae	3.84	1.15	4.99
7	*Cardus sp*	Herb	Asteraceae	4.39	0.58	4.97
8	*Stipa sp*	Herb	Poaceae	3.29	0.77	4.07
9	*Spergularia sp*	Herb	Caryophyllaceae	3.29	0.36	3.65
10	*Noaea mucronata*	Shrub	Chenopodiaceae	3.29	0.18	3.47
11	*Erodium sp*	Herb	Geraniaceae	2.74	0.12	2.86
12	*Hordeum sp*	Herb	Poaceae	2.20	0.46	2.65
13	*Carex sp*	Herb	Cyperaceae	1.65	0.44	2.08
14	*Phalaris sp*	Herb	Poaceae	1.65	0.28	1.92
15	*Papaver sp*	Herb	Papaveraceae	1.65	0.08	1.73
16	*Pimpinella sp*	Herb	Apiaceae	1.10	0.28	1.38
17	*Filago sp*	Herb	Asteraceae	1.10	0.08	1.18
18	*Hippocrepis sp*	Herb	Fabaceae	1.10	0.08	1.18
19	*Fumaria sp*	Herb	Fumariaceae	1.10	0.06	1.16
20	*Trifolium sp*	Herb	Fabaceae	1.10	0.04	1.14
21	*Aegilops sp*	Herb	Poaceae	0.55	0.14	0.69
22	*Calendula sp*	Herb	Asteraceae	0.55	0.04	0.59
23	*Polygonum sp*	Herb	Polygonaceae	0.55	0.04	0.59
24	*Rananculus sp*	Herb	Ranunculaceae	0.55	0.04	0.59
25	*Lactuca sp*	Shrub	Asteraceae	0.55	0.02	0.57
26	*Helianthemum sp*	Herb	Cistaceae	0.55	0.02	0.57
27	*Anemone sp*	Herb	Ranunculaceae	0.55	0.02	0.57

Table 3. Relative Frequency (RF), Relative Density (RD) and Importance Values (IV) of plant families of North Facing site.

Number	Family	RF	RD	IV (0-200)
1	Poaceae	36.78	89.20	126.98
2	Chenopodiaceae	18.66	1.57	20.23
3	Caryophyllaceae	12.07	3.75	16.36
4	Liliaceae	13.18	2.34	15.52
5	Asteraceae	2.59	0.75	7.30
6	Geraniaceae	2.74	0.12	2.86
7	Fabaceae	2.20	0.12	2.31
8	Cyperaceae	1.65	0.44	2.08
9	Papaveraceae	1.65	0.08	1.73
10	Apiaceae	1.10	0.28	1.38
11	Fumariaceae	1.10	0.04	1.16
12	Ranunculaceae	1.10	0.06	1.16
13	Polygonaceae	0.55	0.04	0.59
14	Cistaceae	0.55	0.02	0.57

Table 4. Relative Frequency (RF), Relative Density (RD) and Importance Values (IV) and form of Vegetation of South Facing site.

Number	Species	Form	Family	RF	RD	IV (0-200)
1	*Stipa sp*	Herb	Poaceae	36.00	94.25	130.25
2	*Poa bulbosa*	Herb	Poaceae	22.00	4.58	26.58
3	*Salsola vermiculata*	Shrub	Chenopodiaceae	9.00	0.20	9.20
4	*Lolium sp*	Herb	Poaceae	6.00	0.26	6.26
5	*Allium sp*	Herb	Liliaceae	5.00	0.30	5.30
6	*Carex sp*	Herb	Cyperaceae	5.00	0.07	5.07
7	*Hordeum sp*	Herb	Poaceae	4.00	0.07	4.07
8	*Avena sp*	Herb	Poaceae	3.00	0.10	3.10
9	*Lactuca sp*	Shrub	Asteraceae	2.00	0.06	2.06
10	*Noaea mucronata*	Shrub	Chenopodiaceae	2.00	0.03	2.03
11	*Artimisia herba-alba*	Shrub	Asteraceae	2.00	0.02	2.02
12	*Cardus sp*	Herb	Asteraceae	1.00	0.02	1.02
13	*Anthemis sp*	Shrub	Asteraceae	1.00	0.01	1.01
14	*Polygonum sp*	Herb	Polygonaceae	1.00	0.01	1.01
15	*Spergularia sp*	Herb	Caryophyllaceae	1.00	0.01	1.01

Table 5. Relative Frequency (RF), Relative Density (RD) and Importance Values (IV) of plant families of South Facing site

Number	Family	RF	RD	IV (0-200)
1	Poaceae	71.00	99.26	170.27
2	Chenopodiaceae	11.00	0.23	11.23
3	Asteraceae	4.00	0.11	6.11
4	Liliaceae	5.00	0.30	5.30
5	Cyperaceae	5.00	0.07	5.07
6	Polygonaceae	2.00	0.01	1.01
7	Caryophyllaceae	2.00	0.01	1.01

DISCUSSION

The analysis of the two study sites showed a marked difference in vegetation pattern between north-facing and south-facing slopes. The north-facing boasting a higher diversity (at species and family levels), but less vegetation cover and dry biomass than the south-facing site. This difference is expected since the slope aspect influences microclimatic (most importantly solar radiation and subsequently humidity) and edaphic conditions (Long 1957; Poore and Robertson 1964; Al-Eisawi 1985; Higazy *et al.* 1998; Albaba 2014; Damhoureyeh 2017). In general, north-facing slope receives less solar radiation than south-facing slope; thus, south-facing slope tends to have drier soil (Albaba 2014). The drier soil of the south-facing site supports a limited species and familial diversity, with *Stipa sp* strongly dominating the vegetation. In contrast, the north-facing site supports almost the double of its counterpart's diversity levels and the most important, *P. bulbosa,* dominates to a much lesser degree than *Stipa sp* does in the south-facing site.

Notwithstanding the differences between the two sites, they both show the characteristics of disturbed Jordanian marginal rangeland with low productivity and limited diversity. Poaceae and Chenopodiaceae, dominate both sites; in fact, the three most important species constitute more than 50% of the total abundance in both sites. Furthermore, *S. vermiculata* is the most important shrub species in both sites of the study area.

Conclusions: Visual inspection and limited taxonomic diversity verified that the studied sites are far from pristine and are highly degraded (Abu-Zanat*et al*. 2004; Al-Bakri and Abu-Zanat 2007). This is not surprising that the prevailing land use practices in the area such as grazing, encroachment of agricultural and urban development. Poaceae (herbaceous), represented by *P. bulbosa* and *Stipa sp*, constituted the largest family with the highest IV index in both sites, while Chenopodiaceae (shrub), represented by *S. vermiculata*, came in second. Despite general similarities, some clear differences were observed between the two sites, including a much reduced species richness and family diversity in the south-facing site and two different species coming on top in the IV index: *P. bulbosa* in north-facing site and *Stipa*

sp in south-facing site. The latter result indicates that geographic aspect measurably influences diversity and species composition in marginal rangeland.

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