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Quantifying of plant species diversity, composition and density at Dammam Region, Eastern province, Saudi Arabia

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This study assessed the diversity composition and density of plant species at Dammam Region, Eastern Province, Saudi Arabia. Plant diversity is a vital component of any ecosystem. It is a well-known fact that, worldwide, thousands of plant species are endangered and facing extinction with the current trend of their influence and destruction. Changes in the structure of the assortment of resources lessen plant community's opportunity to respond to new problems and occasions. Plant diversity is facing danger of new plant diseases or pests, species extinction, climatic changes and other obstructions. A survey of 12 different sites was done and botanic biodiversity was evaluated. The plant diversity was evaluated by applying different methods namely: relative abundance index, species richness D* index and Shannon-Weaver index. It is clear that many plant species and habitats of Dammam area are subjected to severe disturbance due to new constructions without environmental impact assessment.

Key words: Biodiversity, biodiversity measures, endangered species, relative abundance index, species richness D*, Shannon-Weaver index.

INTRODUCTION

In the last three decades, there is a massive development in construction and industrial activities at Saudi Arabia. More or less parallel to national development, there is a growing awareness concerning the impact of temperature rise, industrialization, desertification and shift in the growing seasons of plants, loss of pollinators and seed dispersers, and increasing frequency of forceful weather events such as drought, storms and floods, making several valuable plants to be extinct (Bapat et al., 2012; Gardener et al., 2009). According to the International Union of Conservation of Nature (IUCN 1980), it is estimated that the current species extinction rate is between 1000 and 10,000 times higher than it would naturally be. It is acknowledged that the future survival of humanity depends on the conservation and protection of natural wealth, and destruction of a species or a genetic line symbolizes the loss of a unique resource. This type of genetic and

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(A) (B)

Figure 1. (A) Map of the study area illustrating the sampling sites. **(B)** Satellite map of Arabian Gulf, Saudi Arabia, showing the study areas.

environmental deprivation is irreversible (Poi, 2011). The single most important botanical task in eco-civilization construction is the conservation of plant species with their genetic diversity (Hamilton et al., 2017). The environmental factors affect the plant species composition and the establishment and stability of seedlings. Furthermore, the interactions of environmental factors are important in the restoration process and must be considered in the management of the areas (Gattie et al., 2003).

In fact, there is no doubt that plants grow naturally in different environments and are exposed in these environments with a range of climatic factors that suit their growth and sometimes exceed conditions that are not commensurate with their requirements for growth. Soil types with different structure and nutrients are important for plant growth and community development. Although, 95% of experimental studies support a positive relationship between diversity and ecosystem functioning, many have found that only 20 to 25% of species are needed to maintain most biogeographically ecosystem processes (Schwartz et al., 2000).

Rahman et al. (2004) investigated the medicinal plant diversity in the flora of the Kingdom of Saudi Arabia; this communication emphasizes the importance of setting up conservation priorities, and sustained development of various medicinal plants of Saudi Arabia. Saudi Arabia has a hot desert climate and rainfall is scarce in most parts of the country. The diversity of the flora of Saudi Arabia as well as other countries in the peninsula has received less attention for a long time due to its arid climate. The climatic and anthropogenic factors are the most vital factors affecting plant species distribution and abundance (Emad and El-Ghazali, 2013; Kaky and Gilbert, 2016, El-Shabasy, 2016).

In the current study, different measures of plant diversity are introduced with an effective indicator of underlying feature diversity. Phylogenetic diversity will be viewed based on cladistics relation among any group of taxa, not just species (Faith, 1992; Alfarhan, 1999). Regarding conservation priorities, the measurements developed in the present study was initially intended for application on species, population and ecosystem levels. However, since it is not an easy task, the study of plant diversity with time over specific place is highly required. The purpose of the present study is to shed light on assessment of plant species diversity, composition and density at Dammam Region, Eastern province of Saudi Arabia. Plant resources are a vital measure of a country's wealth. Its unsustainable use can lead to irreversible/permanent destruction to the ecosystems.

MATERIALS AND METHODS

Study area

This study is conducted at Dammam city and varsities with an area of about 800 km^2. Dammam is a city found in Eastern Province, Saudi Arabia. It is located at 26.43° Latitude and 50.10° Longitude and it is situated at elevation of 10 m above sea level. The studied site is illustrated in Figure 1. Geomorphologically, Dammam Region is characterized by its low surface with gradual elevation towards north and lake of Wadies. It lies within the Central coastal lowland subregion of Eastern costal region.

Climatically, the study area is classified as an arid to extremely arid region (UNESCO, 1977). The mean annual rainfall is 6.6 mm. The dominant temperature fluctuates between mean minimum of 10.2°C and mean maximum of 44.6°C.

Collection of data

Several field trips were done in and 12 sites were investigated (Tables 2 and 3). In each site, the plant species are listed by evaluating several parameters. The collected plant specimens were identified and named according to Mandaville (1990), Migahaid (1996) and Chaudhary (1999, 2000, 2001). Calculations of various vegetative parameters are according to Magurran (2003).

Field study

In addition to determination of the community type, plant covers, number of individuals per m^2 for each species, also, phenology and soil feature are recognized. All sites were documented with different photos and by GPS.

Samples of obscure plant species were collected, pressed and preserved on paper sheets for full identification. Some soil samples were collected to compare habitat features of plants common in different localities. Twelve soil samples were collected, covering different plant communities and habitats.

Field visits were repeated to the study area to investigate communities and plant species and make the following measurements:

1. A list of the plants "with complete scientific identification", with a case study of each species, growth aspects and phonological features.
2. Species richness of the vegetation in studied sites were calculated as the average number of species per stand, and species index D* turn-over as the ratio between the total number of species in the sample (N) and the number of species (S):

Species richness index D* = (S - 1)/Log N

3. Relative abundance index" Ra" was calculated; Ra = N × 100/N, where N is the number of a species and Ns is the total numbers of all individuals. The results are categorized according the following scale: Dominant species = >70%, abundant spp. = 40 to 70%, frequent = 10 to 40% and rare spp. = <10%
4. Relative evenness "H" of species are calculated using Shannon-Weaver (Pielou, 1975), on the basis of the relative cover of species.

$$H = - \sum Pi \times LnPi$$

Soil analysis

Soil samples were collected at 3 random points from each site as a profile (composite samples) from two depths: surface layer 0-5cm and active absorbing layer 5-30cm depth. Soluble chlorides were determined by precipitation by AgCl and titration, also, sulphates and ammonia (ppm) were precipitated gravimetrically and estimated according to A.O.A.C (1998). Major cations such as sodium, potassium, calcium and magnesium are determined in the 1:5 soil extract by flame photometer (Jones, 2001) and their concentrations are expressed in mg kg^{-1} dry soil.

RESULTS

In the field study, 40 plant species were investigated, some of which are medicinal plants such as: *Neurada procumbans, Zygopyllum qatarense*, *Heliotropium ramosissimum*. Other species belongs to pasture plants e.g. *Puncum turgedum*, *Alhagi maurorum, Poa annua.* On the other hand, the recorded plant species belong to different habitat classes namely: xerphytic, hydrophytic, halophytic and mesophytic habitat (Figures 2 to 6). With regards to life form; the studied plants can be grouped into geophytes: *Asphodelus hemicryptophyts*; phaneropytes: *Acaccia*; therophytes: *Chenopodium*, *Lotus lalambensis.*

Data in Table 1 indicates that soils supporting the growth of vegetation at study area are rich in calcium (68330 mg/kg) at site 8, sodium (49710 mg/kg) at site 2 and magnesium (8960 mg/kg) at site 8. Ammonia and chloride are commonly low in the studied area except site 3 where it reached 79682.33 ppm in surface soil layer.

The soil samples from sites 11 and 12 (Figure 1) have very low level of element contents. Some species are subjected to extensive decrease, over grazing and/or over collection (Table 2), namely: *Haloxylon salicornicum*, *Rhanterium epapposum*, *Seidlitzia rosmarinus*, *Panicum turgidum*, *Zygophylleum qatarence*, *Aleuropus lagopoides*, *Tamarix aphylla* and *Saueda aegyptiaca*.

Table 3 shows the plant diversity parameter of the studied area. Species richness index and Shannon-Weaver index values illustrate low diversity in the majority of the investigated sites of Dammam area. A total of 40 species representing 21 families are recorded. The family, Asteraceae and Chenopodiaceae are represented by the highest number of species (5 species) followed by, Poaceae and Zygophyllaceae (4 species), and Aizoaceae, Asphodelaceae, Fabaceae, Convolvulaceae and Polygonaceae (2 species), whereas other families such as, Brassicaceae, Cyperaceae, Geraniaceae, Juncaceae, Juncaceae, Lilliaceae, Malvaceae, Neuradaceae and Orobanchaceae are represented by a single species each (Figure 7).

Species diversity

The Shannon-Wiener's diversity index ranging from 2.815 to 0.588 are recorded for sites 6 and 7, respectively (Table 3). Relative abundance values for each site show that majority of the investigated species are within the rare category with one dominant species (Table 3). Figures 7 and 8 illustrate number of families and species in the study area.

DISCUSSION

Climate change is a crucial factor to consider when assessing the health of any species' population, but conservationists are left with the challenge of deciding exactly how to measure its potential impact on a given species (Still et al., 2015). It is worth mentioning that the vegetation is subjected to severe arid conditions, with prevalent climatic conditions in the area. Soil analysis (Table 1) illustrate wide diverse of chemical composition of soils supporting the growth of prevailing species of the study area.

Table 2 illustrates that the dominance and abundance of plant species varies widely. The existing species can be classified into different categories: Folk industries plants, medicinal plants, fodders/grazing plants and edible/food plants. Moreover, the results of species relations and soil factors revealed the fact that different species have reacted to soil differently.

The most conspicuous plant communities in this region are dominated by: *H. salicornicum*, *R. epapposum*, *P. turgidum*, *Calligonum comosum*, *Ephedra alata*, *Achillea fragrantissma– Artemisia siebri*, *Haloxylon persicum*, *Cornulaca arabica* and *Calligonum crinitum*, as well as

Table 1. Some chemical features of the soil supporting the growth of studied vegetation in different sites of Dammam area.

No	Depth (cm)	Sulfate (ppm)	Chloride (ppm)	Ammonia (ppm)	Magnesium (mg/kg)	Calcium (mg/kg)	Potassium (mg/kg)	Sodium (mg/kg)
1	0 - 5	160±8.0	123±10	10.15±0.5	3680±380	33470±3270	148.31±25.03	159.11±10.45
	5 - 30	25±6.0	19±2.0	7.35±1.35	2650±290	28190±4130	77.86±24.7	42.76±2.3
2	0 - 5	7111.5±296.5	79682.33±7432.5	5.6±1.5	8120±680	39140±4620	2919.08±356.74	49710±3410
	5 - 30	6963.5±869.5	5543±161	4.75±1.85	6900±620	39660±20	579.08±31.56	2860±40
3	0 - 5	479±65	392.73±83.25	3.95±0.55	4660±100	33840±860	172±22	172.48±80.12
	5 - 30	242±23	49.5±14.5	3.25±0.15	3680±200	30430±1810	102.46±19.78	58.8±9.42
4	0 - 5	674.5±78.5	119±18	11.25±3.95	5400±340	32860±1900	84.13±10.95	58.32±7.56
	5 - 30	74.5±23.5	82.25±3.25	3.35±0.25	3280±1060	28950±10670	161.98±25.98	84.95±30.95
5	0 - 5	2873.5±373.5	229.5±.50	5.65±0.95	5350±210	31340±1640	197.9±23.36	178.74±.74
	5 - 30	546±45	309±3	6.79±0.26	3920±40	32860±700	219.22±19.02	247.72±3.16
6	0 - 5	1538.1±234.7	4748.5±1767.5	8.4±1.3	6870±230	33140±1120	263.99±100.47	3072±748
	5 - 30	2060.5±147.5	182.5±58.5	6.15±0.95	5240±140	33070±2390	160.17±33.53	184.59±58.41
7	0 - 5	405±133	150.73±25.25	18.1±2.1	6530±570	41350±1550	305.31±51.97	101.78±0.38
	5 - 30	68±3.0	23±4.0	13.2±2.8	4500±480	35190±3790	242±49.26	73.36±9.66
8	0 - 5	700±7	169±1.0	7.7±1.1	8960±180	68330±450	517.05±27.91	153.6±26
	5 - 30	665.5±41.5	11.5±0.5	11.85±1.65	8360±380	63490±3890	507.57±57.67	144.7±7.7
9	0 - 5	131±7.0	129.5±5.5	25.1±8.1	3890±290	31980±1900	139.87±24.15	64.3±4.9
	5 - 30	66±4.0	31±0.0	15.25±4.75	1850±510	19740±6060	105.88±22.1	55.8±2.8
10	0 - 5	306±43	92±10	17.35±0.85	3700±20	36280±2320	189.54±5.43	143.1±6.1
	5 - 30	35.5±5.5	15.5±1.5	10.5±2.8	2840±660	32660±7500	152.11±60.29	60.86±43.71
11	0 - 5	41.36±2.76	155±119.45	2.44±0.48	11.13±2.3	85.2±6.53	6.13±0.15	2±0.0
	5 - 30	64.4±5.04	132.33±178.16	2.34±0.54	15.63±2.4	89.5±4.4	9.63±0.8	4±3.0
12	0 - 5	19.85±6.12	249±63	1.65±0.01	39.53±20.87	109.4±25.83	63.2±57.45	192±151.43
	5 - 30	48.2±11.93	76.66±21.5	1.49±0.19	11.9±3.45	62.86±32.61	15.2±2	42.66±17.21

the annual shrubless community of *Stipa capensis*, and some succulent halophyte communities (Migahid, 1996; Mandaville, 1990). The vegetation in the study area is the desert shrub rangelands type (Rahman et al., 2004).

A floristic analysis shows that majority of plants in the study area are annuals, while the minority group is in the tree (Figures 7 and 8). The dominance of members of Asteraceae and Chenopodiaceae, followed by Poaceae and Zygophyllaceae coincides with the findings of authors such as Turki and Al-Olayan (2003), El-Ghanim et al. (2010) and Alatar et al. (2012). On the other hand, the rainy season provides better chance for the appearance of a considerable number of annuals, which give a characteristic physiognomy to their vegetation (Shaltout and Mady, 1996; Hosni and Hegazy, 1996; Shaltout et al., 2010; Alatar et al., 2012). Moreover, the life form spectrum in eastern part of the study area reflects a typical desert flora, the majority of species being therophytes and chamaephytes. These results agree with the spectra of vegetation in desert habitats in other parts of Saudi Arabia This indicates that the dominance evenness of species generally tend to be within low values indicating low diversity.

Figure 2. *Erodium cicutarium* growing in Site 3.

Figure 3. *Cakile arabica* growing at Site 4.

Figure 4. *Caletropus procera* and *Zygophyllum coccinum* growing in Site 7.

Figure 5. Photo showing low diversity among site dominated with *Zygophyllum coccinum.*

Figure 6. *Convolvulus oxyphyllus,* one of endangered species collected from El Rayan district- Dammam City (Site 6).

Table 2. Endangered species recorded in the study area.

Species	Family	Phenology	Relative abundance index
Convolvulus oxyphyllus	Convulvulaceae	Veg./Fl.	Rare
Haloxylon salicornicum Rhanterium	Amaranthaceae	Veg./Fl.	Rare
epapposum	Composite	Veg./Fl.	Rare
Seidlitzia rosmarinus	Chenopodiaceae	Veg./Fl.	Rare
Panicum turgidum	Gramineae	Veg./Fl.	Rare
Zygophylleum qatarence	Zygoph*yllaceae*	Veg./Fr.	Rare
Aleuropus lagopoides	Gramineae	Veg./Fr.	Rare
Tamarix aphylla	Tamaricaceae	Veg.	Rare
Saueda aegyptiaca	Chenopodiaceae	Veg.	Rare
Avecinia marina	Aviciniaceae	Veg.	Frequent

Table 3. Relative abundance, species richness index D* and Shannon-Weaver index of plant species grown in the studied area at Dammam.

Site	Species	Family	Phenology	Density (No./m^2)	D*	Ra	H
1	*Launaea mucronata* (Forssk.) Muschl.	Asteraceae	Fl.	1	0.08±0.001	0.57% Rare	0.638±0.02
	Cakile arabica Velen.& Bornm.	Brassicaceae	Fr./Veg.	10		5.70% Rare	
	Kochia indica Wight.	Chenopodiaceae	Fr.	150		85.22% Dom	
	Heliotropium ramosissimum (Lehm.) DC.	Boraginaceae	Fr.	3		1.70% Rare	
	Malva parviflora L.	Malvaceae	Fr. Fl.	1		0.57% Rare	
	Poa annua L.	Poaceae	Fr.	3		1.70% Rare	
	(L.) Campd. *Emex spinosa*	Polygonaceae	Veg.	8		4.55 % Rare	
2	Bioss.& Sprum *Lotus halophilus*	Fabaceae	Fl.	3	0.72±0.02	4.34% Rare	1.232±0.11
	Erodium cicutarium (L.) L'Her.	Geraniaceae	Fr./Veg.	6		8.70% Rare	
	Malva parviflora L.	Malvaceae	Fr.	25		36.23% Freq.	
	annua L. *Poa*	Poaceae	Fr.	30		43.5% Abun.	
	Neurada procumbens L.	Neuradaceae	Fl./ Fr.	4		5.80% Rare	
	Senesio flavus (Decne) Sch. Bip	Asteraceae	Fr./Fl.	1		1.45% Rare	
3	*Chenopodium murale* L.	Chenopodiaceae	Fr./ Fl.	1	1.27±0.09	8% Rare	1.221±0.12
	Cakile arabica Velen.& Bornm.	Brassicaceae	Fr./Veg.	5		41 % Abun.	
	Asphodelus fistulosus L.	Asphodelaceae	Fr.	2		17 % Freq.	
	G. agea reticulata (Pall.)J.A.& J.H. Schultes	Lilliaceae	Veg.	2		17 % Freq.	
	Calotropis procera (Aiton) W.T.Aiton	Solanaceae	Veg.	2		17 % Freq.	
4	*Launaea mucronata* (Forssk.) Muschl	Asteraceae	Fl.	5	0.93±0.02	11.90% Freq.	1.380±0.13
	Heliotrpium digynum (Forssk) Ash.ex C. Christ.	Boraginaceae	Fr./Veg.	11		26.1% Freq.	
	Neurada procumbens L.	Neuradaceae	Fr.	20		47.62%Abun.	
	Lotus garcinii DC.	Fabaceae	Fr.	1		2.38% Rare	
	Poa annua L.	Poaceae	Fl./Fr.	2		4.76% Rare	
	Kochia indica Wight.	Chenopodiaceae	Fr.	3		7.14% Rare	
5	*Mesembeyianthemum nodiflorum* L.	Aizoaceae	Veg.	4	2.07±0.12	21.05% Freq.	2.412±0.21
	Aizoon hispanicum L.	Aizoaceae	Veg.	1		5.26% Freq.	
	Malva parfviflora L.	Malvaceae	Fr.	3		21.05% Freq.	
	Chenopodium album L.	Chenopodiaceae	Fr.	4		15.79% Freq.	
	Senesio flavus (Decne) Sch. Bip		Fl./Fr.	3		10.52% Freq.	
	Launaea capitata (Spreng.)	Asteraceae	Fr./Fl.	2		5.26%Rare	
	Fagonia indica Burm.f.	Asteraceae	Fr.	1		5.26% Rare	
	Cyperus conglomeratus Rottb.	Zygophyllaceae Cyperaceae	Veg.	3		10.52% Freq.	
	Asphodelus viscidulus Boiss.	Asphodelaceae	Veg.	2		5.26 % Rare	
6	*Convolvulus oxyphyllus* Boiss.subsp. *Oxycladus* Rech.f.	Convovulariaceae	Veg.	1	2.16±0.09	74.1% Rare	2.815±0.17
	Aizoon hispanicum L	Aizoaceae	Veg.	4		816.6% Freq.	
	Malva parfviflora L.	Malvaceae	Fr.	6		24.96% Freq.	
	Saueda aegyptiaca (Hasselq.) Zoh.	Chenopodiaceae	Fr.	3		12.48% Freq.	
	Seidlitzia rosmarinus Bunge ex Boiss.	Chenopodiaceae	Fl./Fr.	1		4.17 % Rare	
	Launaea capitata (Spreng.)	Asteraceae	Fr./Fl.	2		48.3% Rare	
	Fagonia indica Burm.f.	Zygophyllaceae	Fr.	3		12.48% Rare	
	Cyperus congrtulus	Cyperaceae	Veg.	2		48.3% Freq.	
	Asphodelus fistulosus L.	Asphodelaceae	Veg.	1		74.1% Rare	
	Aeluropus lagopoides (L.) Trin ex Thawaites	Poaceae	Fr.	1		4.17% Rare	

Table 3. Contd.

	Erodium cicutarium (L.)L'Her.	Geraniaceae	Fr.	120		85.11% Dom	
	Juncus rigidus Desf.	Juncaceae	Veg.	2		1.42% Rare	
	Salsola baryosma (Roem.et Schult.) Dandy	Chenopodiaceae	Fr.	4		2.84% Rare	
7	*Zygophyllum coccineum* L.		Fr.	4	0.51±0.07	2.84% Rare	0.594±0.01
	Malva parviflora L.	Zygophyllaceae Malvaceae	Fl./ Fr.	7		4.96% Rare	
	Panicum turgidum Forssk.	Poaceae	Fr./ Fl.	2		1.42% Rare	
	Bioss.&Sprum *Lotus halophilus*		Fr.	4		12.5% Freq.	
	Salsola imbricata Forssk.	Fabaceae Chenopodiaceae	Veg.	1		3.12% Rare	
	Zygophyllum coccineum L.	Zygophyllaceae	Fr.	4		12.5% Freq.	
8	*Poa annua* L.	Poaceae	Fr.	4	1.24±0.21	12.5% Freq.	1.588±0.09
	Panicum turgidum Forssk.	Poaceae Neuradaceae	Fl./Fr.	15		46.87% bun.	
	Neurada procumbens L.	Poaceae	Fr./Fl.	2		6.25% Rare	
	Lasiurus scindicus Henr.		Fl./Fr.	2		6.25% Rae	
	Phragmites australis (Cav.) Trin.&Steudel.	Poaceae	Fr.	35		53.85%Abun.	
	Mesemberianthemum nodiflorum L.	Aizoaceae	Veg.	3		4.62% Rare	
	Zygophyllum coccineum L.	Zygophyllaceae	Fr.	1		1.54% Rare	
	Juncus rigidus Desf.	Juncuaceae	Fr.	1		1.54% Rare	
9	*Heliotrpium bacciferum*Forssk	Boraginaceae	Fl./Fr.	15		23.08%Freq.	1.397±0.17
	Salsola baryosma (Roem.et Schult.) Dandy	Chenopodiaceae	Fr./Fl.	1	1.12±0.12	1.54% Rare	
	Cressa cretica L.	Convolvulaceae	Fr./ Fl.	6		9.24% Rare	
	Sonchus oleracus L.	Asteraceae	Fl./ Fr.	2		3.08% Rare	
	Neurada procumbens L.	Neuradaceae	Fr.	1		1.54% Rare	
	Fagonia indica Burm.f.	Zygophyllaceae	Fr.	4		20% Freq.	
	Cakile Arabica Velen.&Bornm.	Brassicaceae	Veg.	1		5% Rare	
	Sonchus oleraceus L.	Asteraceae	Fr.	5		25% Freq.	
10	*Malva parviflora* L.	Malvaceae	Fr.	2	1.42±0.06	10% Freq.	1.675±0.21
	Heliotrpium bacciferum Forssk.	Boraginaceae	Fr./ Fl.	2		10% Freq.	
	Senesio flavus (Decne) Sch. Bip.	Asteraceae	Fr./ Fl.	4		20% Freq.	
	Malva parviflora L	Malvaceae	Fr.	5		30.33% Freq.	
	Senecio glaucus L.	Asteraceae	Fr.	6		35% Abun.	
11	*Calotropis procera* (Aiton) W.T.Aiton	Solanaceae	Veg .	2	0.780±0.01	11.2% Freq	1.086±0.08
	Heliotrpium digynum (Forssk) Ash.ex C.Christ.	Boraginaceae	Fr.	4		22.67% Freq.	
	Fagonia schweinfurthii (Hadidi) Hadidi	Zygophyllaceae	Fr.	2		6.06% Rare	
	Tamarix nilotica (Ehrenb.) Bung	Tamaricaceae	Veg.	1		3.03% Rare	
	Calligonum comosum (L.)L'Her.	Polygonaceae	Fr.	3		9.09% Rare	
	Juncus rigidus Desf.	Juncaceae	Fr.	11		33.33% Freq.	
12	*Salsola kali* L.	Chenopodiaceae	Fl./ Fr.	1	1.74±0.01	3.03% Rare	2.047±0.12
	Phragmites australis (Cav.) Trin & Steudel.	Poaceae	Fr./Fl.	2		6.06%Rare	
	Cakile arabica Velen.&Bornm.	Brassicaceae	Fr./ Fl.	2		6.06% Rare	
	Zygophyllum qatarense Hadidi	Zygophyllaceae	Veg./Fl.	4		12.12%Freq.	
	Kochia indica Wight.	Chenopodiaceae	Fr.	4		12.12% Freq.	
	Cistanc hephelypaea(L.)Cout.	Orobanchaceae	Veg./Fl.	3		9.09 % Rare	

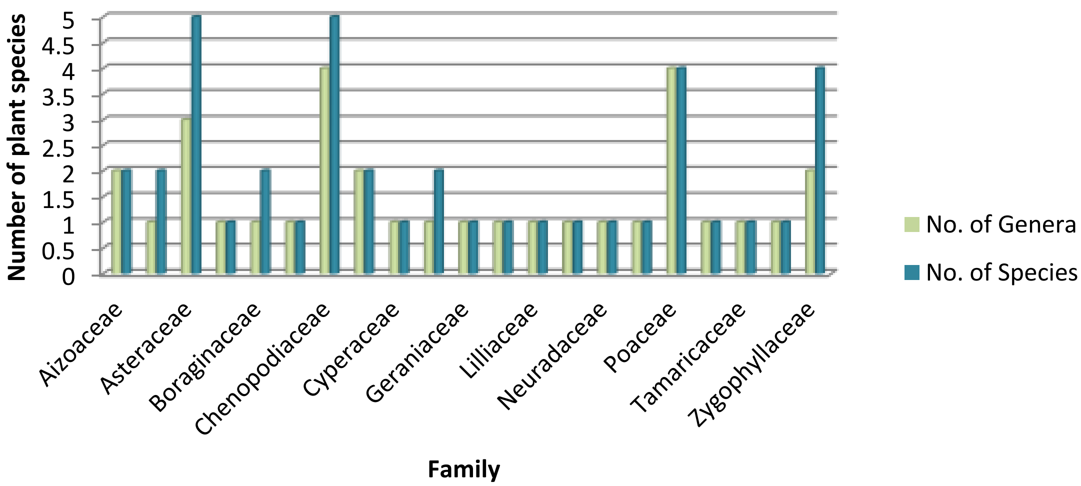

Figure 7. Number of families and species in the study area.

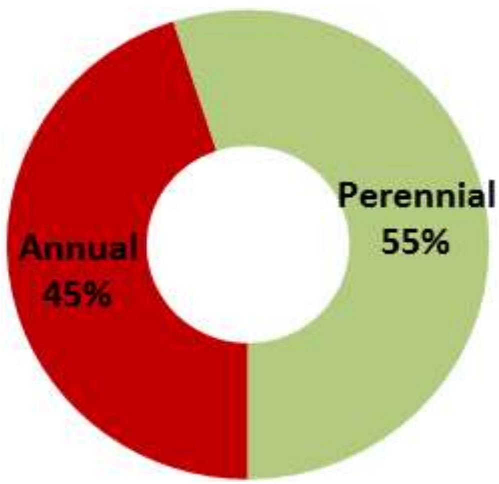

Figure 8. Growth of relative spectrum of the study area.

Degradation of the rangeland is evident in many parts of Saudi Arabia as a result of a long history of overgrazing (camels and sheep are the main grazing animals), overcutting, and many social, economic and cultural factors (Miller and Nyberg, 1991; Schultz and Whitney, 1986; Al-Rowaily et al., 2015). Protection against overexploitation provides a chance for regeneration of vegetation and for improvement of phytomass levels (Thomas et al., 2017). This is emphasized by many investigators (Gilbert, 2011; Pan et al., 2012; Chafjiri et al., 2016).

Generally, the plant diversity in the study area is extremely important from the environmental point of view as well as the economic importance. The environmental value is represented by: sand dune fixation, wind breaks, phytoremediation, atmospheric filtration and ecological balance, etc. (Meshal et al., 1985; Al-Taisan, 2009; Adler, 2011). Individual ecosystem functions generally show a positive asymptotic relationship with increasing biodiversity, suggesting that some species are redundant (Hector and Bagchi, 2007).

The diversity measurements (Table 3) illustrate low diversity of vegetation in the most studied sits. The plant diversity in Dammam sharply needs intensive conservation program, integrated studies and contentious monitoring. To overcome these hurdles, there is a need for coordinated efforts of scientists, government departments and nongovernmental organizations to undertake effective strategies for conservation of plants at Dammam area. This is emphasized by Shaltout et al. (1996). They found that 14 years of protection against grazing and human impacts of the coastal lowland vegetation in Eastern Saudi Arabia has led to an increase of 68% in the total cover, 33% in species richness and 32% in species relative evenness. Many of the species with significantly higher abundance in the protected area are important forage and/or fuel plants.

Conclusion

The study revealed that the high plant diversity and distribution of many plant species are deteriorated in Dammam due overgrazing and social behavior. Therefore, the plant diversity in Dammam sharply needs intensive conservation program, integrated studies and contentious monitoring. To overcome these hurdles, there is a need for coordinated efforts of scientists, government departments and non-governmental organizations to undertake effective strategies for conservation of plants at Dammam area.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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