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Research article

CONSERVATION OF PLANT DIVERSITY AT SOME WADIS IN SOUTH WESTERN KSA

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ABSTRACT: The conservation strategy goal is to strengthen plant communities with high biodiversity. Wadis are one of the important areas of Tehamah region (Saudi Arabia) sheltering a rich diversity of higher plants. The study area is extended into approximately100 km^2 encompassing the commonest geomorphological features encountered in desertwadis. The studied wadis (Khedran, Rash, Maleil) support several rare plants, including a regionally endangered tree, *Acacia ehrenbergiana* Hayne, *Atriplexhortensis* L., *Anisitusrisoolaus* L. and *Aervajavanica* L., a rare shrub with restricted distribution.The present study aims to maintain their existence and health,a management system must be established. The vegetation type is fundamentally of chamaephytic nature with some phanerophytes, and distinguished into associations where the dominant perennial species givethe permanent character of plant cover in each habitat. Three vegetation groups above were identified by named with Chaudary book with main associates of *Cassia acutifolia* Mill.; *Calotropisprocera* L.and *Aervajavanica* L. These plant with associations demonstrate significant variation in soil texture, moisture, organicmatter, pH, EC, and minerals of Wadi Mangal. Many measurements and calculations were done. Pioneer data were recorded for these three wadis.
Key words: Climate, conservation, death, endemic, rare, soil, vegetation, wadis.

INTRODUCTION

Desert ecosystems over erases subjected into severe temperature, precipitation, rain, humidity, wind, barometric pressure, and other phenomena. Due towad is plants at risk, more than half of them are endangered. Vegetation production, including access to food, in many Asian countries such as KSA and sub-regions is projected to be severely compromised by climate variability and change. The Tehamah area is suitable for distinct vegetation. Many reasons lead to extinct species such as the length of growing seasons. The margins of semi-arid and arid areas of this area are expected to decrease more and more. This would further negatively affect food safety, intensify starvation, and reduced yields up to 50% by 2020. The Tehamah wadi ecosystems are the main plant diversity centers of south western Saudi Arabia [1, 2].Additionally, the importance of study socioeconomic development ecosystems in wadis is increased as a result of its ecological significance, physiographic variation and environmental gradients. The south western region of Saudi Arabia that belongs to Saharo-Arabian phytogeographical zone, consists of small mountains, hillocks, plateaus, desert plains depressions ‘‘Raudhas’’ andwadis [2 - 6].

Plant diversity of wadis is varied from year to year depending on the moisture [7,8],carried out studies in some ‘‘Raudhas’’ to confirm the abundance, frequency and density of exhibited species, while, [9]stated that the distinctiveness of seed bank and their relationship to the desert vegetation is a fundamental part of appreciative the ecological and physiological process of several plants. Abundance of Tehamah natural vegetation is linked with drought and aridity. The recorded species in KSA till nowis 2243 species of higher plants [2, 10-14].Approximately 600 species are recorded at south western Region [2, 12, 13, and 15]. Among these, many are either xerophytes or morphologically and physiologically adapted to manage with the insensitive environment existing in the south western region. [15- 17], proved that wild plants in the south western region which mostly annuals have own characteristics in hostility desertification. Moreover, improving the local climate, conserving soils, fixing sand dunes, stopping erosion and flooding are also accounted.

In view of the fact the wadis Khedran, Rash and Maleil are vegetationally and floristically one of the richest wadis of the south western region. Numerous surveys were performed in this area [10, 18 – 21], have recognized the plant diversity of the Nafud, Dahna and Rub al-Khali, while [22 – 24] deliberate of the sabkhas, hillocks and other prominent mountains of the Tehamah region.[25 – 27] studied he revelation of the ecosystems in raud has, Wadi Hanifa and Wadi Al-Ammaria. [28] Considered the soil of this region Aridisols with no addition of clays or organic matter while they are bottom lessfine-textured plusirregular rocky, sandy or phytogenicmounds [29].
The main objective of the present study is to examine their plant diversity and evaluate the role of edaphic factors and human impact that influences the plant diversity and there by vital methods needed for community conservation.

STUDY AREA

Saudi Arabia has distinguished into many physiographic regions (Fig. 1). The main features of the south western physiographic province of a large south western plateau, ‘‘Tehamah’’, which is divided into ‘‘Higher Tehamah’’ in the western and ‘‘Lower Tehamah’’ in the eastern sides. Studied Wadis are located closest to south west of Tehamah in South western Saudi Arabia. The study areas of Wadi Khedran, Rash and Maleilextend 100 km^2 and protect by mountain range which has an altitude ranging from 600 to 1000 m a.s.l (Fig. 2). They are characterized by their dissection of landscape into an extensive system of large wadis which flow eastward, from the higher mountains in the west to the plains of Tehamah, responding to the general slope of the land. These wadis are not continuous, and at times covered and buried by the sand dunes of Dahna desert. Seasonal springs originate in these wadis during rainy days and often create shallow pools along the banks and depressions. Remnants of dense vegetation can be found along the stretch, reflecting a wetter climate of the past [30, 31]. The dominant topography of the south western province is made up of a nearly parallel sequence of several prominent crescent-shaped, which is mainly of hard marine limestone capped with upper Jurassic limestone, extending for about 1200 km, with elevations up to 850 m a.s.l. and 240 m above the nearby plains [31].

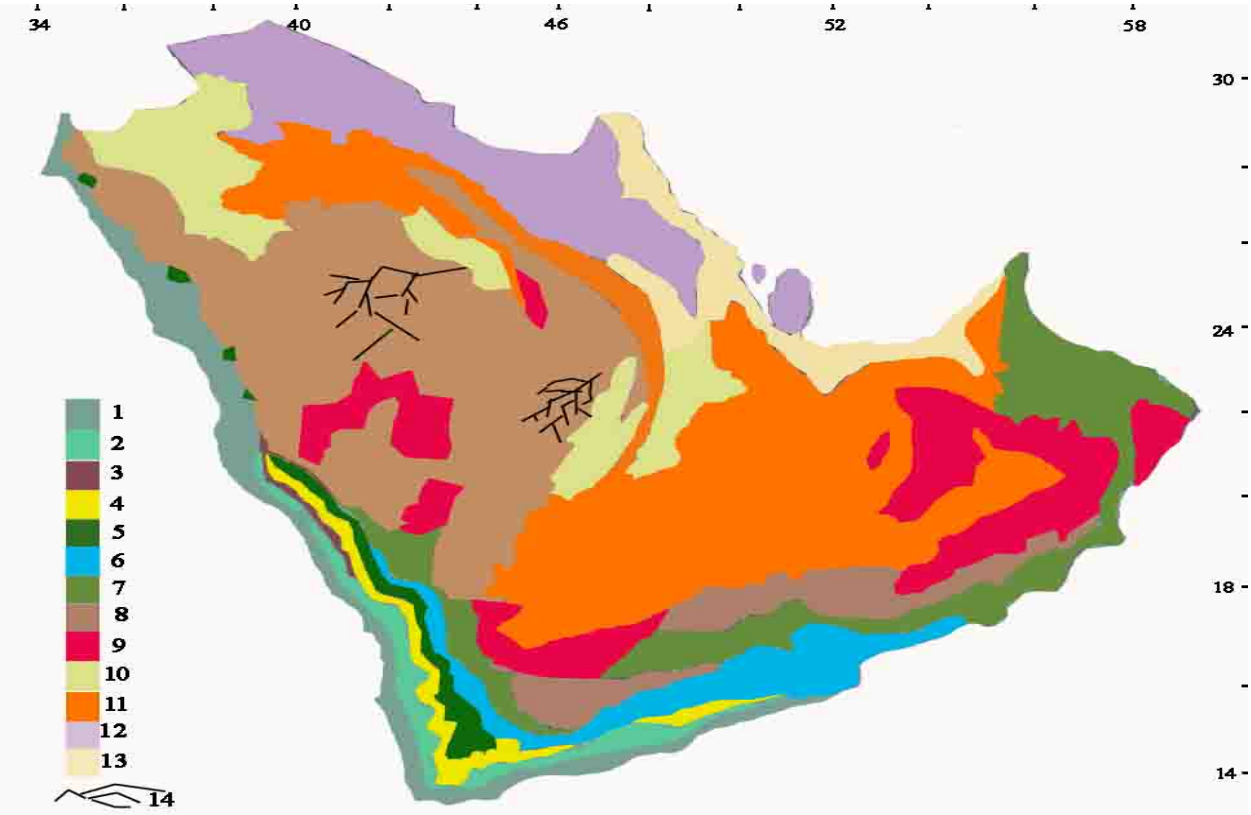

Fig. 1: Physiographic regions Arabian Peninsula.

The vegetation of Wadis are influenced by the topography and soil type of these habitats. These Wadis are somewhat an enclosed habitat protected by Mountains and dissected into an extensive system of several small and big wadis. Despite harsh environment. Wadis ecosystem are diverse in habitats and accordingly the vegetation is different from one habitat to another. During winter, the vegetation of the main wadi and its tributaries is represented by different plant communities, each comprised of trees, shrubs, sub-shrubs and seasonal vegetation represented by mesophytic herbs and grasses. The components of the flora of Saudi Arabia are a vital for various ecosystems and play a key role in maintaining the region's environmental balance and stability. It also helps in the protection of watersheds, stabilization of slopes, improvement of soils, moderation of climate and the provision of a habitat for much of our wild fauna. Ever since the beginning of civilization, the association of man and plants are well known and the basic needs required for man such as food, clothing, fuel, shelter and medicine are fulfilled by plants. Saudi Arabia contains one of the diverse floras of this region. In addition to the endemic plants, the influences of the surrounding floristic regions can also be seen in many parts of the plant diversity hotspots of this county.

Meteorological data of the south western region are characterized by mean air temperature ranging from 25^{o}C in January to52 ^{o}C in July and an annual rainfall from 44 to 112 mm. The mean relative humidity ranges between 10% and 50%, while the mean evaporation value is 10.35 mm/day [31].

MATERIALS AND METHODS

Soil analysis

Three soil samples of each dominant species, down to 50 cm depth, were collected from each stand and mixed as one composite sample for each site. Soil texture was determined by hydrometer method [32]. Total organic matter was determined based on loss on-ignition at 450^{o}C. Soil water extract was prepared (1:5), by dissolving 100 g air dried soil in 500 ml distilled water for estimation of pH and electrical conductivity (EC) as m S cm-1. Soil nutrient elements (Ca, K, Na, Mg, Fe, N and P) were determined using spectrophotometer (model ICP MSEOS 6000 Series). All procedures are outlined by [32].

Vegetation analysis

A mean of 5 for total of 15 stands were selected for each wadi. The stands were distributed along transect on the wadi that covered various landforms (5 stands on the wadi plateau, 5 stands on the wadi slope and 5 stands on the wadi bed and delta). The sampling process was carried out during fall season when most species were expected to be growing season. The vegetation parameters included listing of all species, areas, numbers, density, relative density, dominance, relative dominance, frequency, relative frequency, and important value. Species nomenclature followed [2, 12 -14].Individual plants basal area or coverage may be recorded according to quadrates method [33]. Each quadrate has area 10 x 10 m^2. The individual plants should be identified and measured. The varies of vegetational measurements are determined according to the following formula:

Density = number of individuals/area sampled

Relative Density = Density for a species / Total Density for all species x 100

Dominance = Total of basal area / area sampled

Relative Dominance = Dominance for a species / Total Dominance for all species x 100

Frequency = no. of plot in which species occurs / Total no. of plot sampled

Relative Frequency = Frequency for a species / Total Frequency for all species x 100

Importance value = Relative Density + Relative Dominance + Relative Frequency

Statistical analysis

The variation in the species diversity, stand traits and soil variables in relation to plant community were assessed using one way analysis of variance (SPSS, VERSION 16).

RESULTS AND DISCUSSION

Phenological and status of vegetation

Phenology for plant community of *Cassia acutifolia*Mill at Wadi Khedran – Qalwa Province – Al Baha region is recorded in Table 1. The dominant plant associates are *Citrullus colocynthis, Aerva javanica, Terminalia chebula, Calotropis procera, Acacia ehrenbergiana, Lycium shawii, Cassia italica, Artemisia monosperma, Haplophyllum tuberculatum, Anisotes trisulcus, Leptadenia pyrotechnica, Ziziphus mucronata, Tribulus terrestris, Atriplex repens, Aloe sabaea,* and *Rhanterium epapposum*. The highest density recorded to *Cassia acutifolia* and the lowest to *Aerva javanica,* while the highest value of relative dominance listed to *Cassia acutifolia* and the lowest to *Ziziphus mucronata*.

The highest dominant recorded to *Cassia acutifolia* and lowest to *Rhanterium epapposum*, while the highest value of relative dominance listed to *Cassia acutifolia* and lowest to *Rhanterium epapposum*. The highest frequency recorded to *Cassia acutifolia, Citrullus colocynthis, Aerva javanica* and lowest to*Aloe sabaea*, while the highest value of relative frequency listed to *Cassia acutifolia, Citrullus colocynthis, Aerva javanica* and lowest to *Aloe sabaea*. The highest important value recorded to *Cassia acutifolia* but lowest is to *Calotropis procera* and *Atriplex repens.*

Table 1: Phenology for plant community of *Cassia acutifolia* Mill. at Wadi Khedran – Qalwa Province – Al Baha region. (10 m x 10 m)

Quadrate no.	1		2		3		4		5		Total	Total	DE	RDE	DO	RDO	FR	RFR	IV
Plant name	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	no.	area							
Cassia acutifolia	18	5.5	8	4.4	14	5.8	18	7.8	22	9.7	80	33.2	2.41	16.84	0.13	12.62	1.00	8.93	38.39
Citrullus colocynthis	2	7.7	1	3.1	12	3.8	1	3.5	2	7.7	18	25.8	0.70	4.89	0.10	9.71	1.00	8.93	23.53
Aerva javanica	3	7.6	5	9.9	1	3.5	2	7.7	1	3.1	12	31.8	0.38	2.66	0.12	11.65	1.00	8.93	23.24
Terminalia chebula	3	4.2	3	4.3	1	0.1	0	0	0	0	7	8.6	0.81	5.66	0.03	2.91	0.60	5.36	13.93
Calotropis procera	0	0	0	0	0	0	3	3.4	3	4.1	6	7.5	0.80	5.59	0.03	2.91	0.40	3.57	12.07
Acacia ehrenbergiana	3	7.6	5	9.9	1	3.5	2	7.7	1	3.1	12	31.8	0.38	2.66	0.12	11.65	1.00	8.93	23.24
Lycium shawii	3	3.4	3	4.1	6	7.5	0	0	3	3.4	15	18.4	0.82	5.73	0.07	6.80	0.80	7.14	19.67
Cassia italica	0	0	0	0	3	4.5	3	4.5	0	0	6	9	0.67	11.67	0.00	0.00	0.40	3.57	15.24
Artemisia monosperma	3	7.6	5	9.9	1	3.5	2	7.7	1	3.1	12	31.8	0.38	2.66	0.12	11.65	1.00	8.93	23.24
Haplophyllum tuberculatum	0	0	0	0	7	8.5	1	0.1	0	0	8	8.6	0.93	13.49	0.03	2.91	0.40	3.57	19.97
Anisotes trisulcus	3	3.4	3	4.1	6	7.5	0	0	3	3.4	15	18.4	0.82	5.73	0.07	6.80	0.40	3.57	19.67
Leptadenia pyrotechnica	0	0	0	0	3	4.5	3	4.5	0	0	6	9	0.67	11.67	0.00	0.00	0.40	3.57	15.24
Ziziphus mucronata	3	7.6	5	9.9	1	3.5	2	7.7	1	3.1	12	31.8	0.38	2.66	0.12	11.65	1.00	8.93	23.24
Tribulus terrestris	3	4.2	3	4.3	1	0.1	0	0	0	0	7	8.5	0.81	5.66	0.03	2.91	0.60	5.36	13.93
Atriplex repens	0	0	0	0	0	0	3	3.4	3	4.1	6	7.5	0.80	5.59	0.03	2.91	0.40	3.57	12.07
Aloe sabaea	0	0	0	0	3	4.5	0	0	0	0	3	4.5	0.67	11.67	0.02	1.94	0.20	1.79	15.40
Rhanterium epapposum	0	0	1	0.3	1	0.5	0	0	1	0.8	3	1.6	1.88	13.14	0.01	0.97	0.60	5.36	19.47
Total	**44**	**58.8**	**39**	**67.2**	**51**	**61.1**	**40**	**57.7**		**45.6**	**208**	**261.2**	**14.31**	**127.97**	**1.03**	**99.99**	**11.20**	**10.01**	**331.54**

DE = Density, **RDE** = Relative Density, **DO =** Dominance, **RDO** = Relative Dominance, **FR =** Frequency, **RFR** = Relative Frequency, IV = Important Value

Phenology for plant community of *Calotropis procera* L. at Wadi Rash – Qalwa Province – Al Baha region is listed in Table 2. The dominant plant associates are *Cassia italca, Aerva javanica, Acacia tortilis, Cassia acutifolia, Leptadenia pyrotechnica, Anisotes trisulcus, Acacia ehrenbergiana, Calotropis procera, Salvadora persica, Artemisia monosperma, Ocimum hadiense, Ziziphus mucronata, Rhanterium epapposum* and *Euphorbia cactus*. The highest density recorded to *Acacia tortilis* and lowest to *Ocimum hadiense*, while the highest value of relative density listed to *Acacia tortilis* and lowest to *Ocimum hadiense*. The highest dominant recorded to *Artemisia monosperma* and lowest to *Rhanterium epapposum*, while the highest value of relative dominance listed to *Artemisia monosperma* and lowest to *Rhanterium epapposum*. The highest frequency recorded to *Calotropis procera*, and lowest to *Rhanterium epapposum*, while the highest value of relative frequency listed to *Calotropis procera*, and lowest to *Rhanterium epapposum.* The highest important value recorded to *Acacia tortilis* but lowest is to *Rhanterium epapposum.*

Table 2: Phenology for plant community of *Calotropis procera* L. at Wadi Rash – Qalwa Province – Al Baha region. (10 m x 10 m)

Quadrate no.	1		2		3		4		5		Total	Total	DE	RDE	DO	RDO	FR	RFR	IV
Plant name	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	no.	area							
Calotropis procera	11	7.5	13	7.9	11	7.1	5	5.5	5	4.3	45	32.3	1.39	6.06	0.17	15.74	1.00	9.26	31.06
Cassia italca	3	4.5	0	0	0	0	3	4.5	0	0	6	9.0	0.67	2.92	0.05	4.63	0.40	3.70	11.25
Aerva javanica	1	3.5	2	7.7	1	3.1	1	3.5	2	7.7	7	25.5	0.27	1.18	0.14	12.96	1.00	9.26	23.40
Acacia tortilis	1	0.1	0	0	0	0	1	0.1	0	0	2	0.2	10.00	43.63	0.00	0.00	0.40	3.70	47.44
Cassia acutifolia	0	0	3	3.4	3	4.1	0	0	3	3.4	9	10.9	0.83	3.62	0.06	5.56	0.60	5.56	14.74
Leptadenia pyrotechnica	3	4.5	0	0	0	0	3	4.5	0	0	6	9.0	0.67	2.92	0.05	4.63	0.40	3.70	11.25
Anisotes trisulcus	2	2.3	6	2.3	4	4.4	1	1.1	2	2.3	15	12.4	1.21	5.28	0.07	6.48	1.00	9.26	21.02
Acacia ehrenbergiana	2	1.8	2	1.9	1	1.1	2	2.1	4	3.9	11	10.8	1.02	4.45	0.06	5.56	1.00	9.26	19.27
Calotropis procera	1	1.1	2	1.9	3	2.3	2	2.4	2	2.2	10	9.9	1.01	4.41	0.05	4.63	1.00	9.26	18.30
Salvadora persica	0	0	1	1.1	1	1.1	3	2.8	3	2.8	8	7.8	1.03	4.49	0.04	3.70	0.80	7.41	15.60
Artemisia monosperma	8	5.8	9	6.7	8	6.8	8	7.5	8	7.5	41	34.3	1.19	5.19	0.18	16.67	1.00	9.26	31.12
Ocimum hadiense	1	3.5	2	7.7	1	3.1	1	3.5	2	7.7	7	25.5	0.27	1.18	0.14	12.96	1.00	9.26	23.40
Ziziphus mucronata	3	4.2	3	4.3	1	0.1	0	0	0	0	7	8.6	0.81	3.53	0.05	4.63	0.60	5.56	13.72
Rhanterium epapposum	0	0	0	0	3	4.5	0	0	0	0	3	4.5	0.67	2.92	0.02	1.85	0.20	1.85	6.08
Euphorbia cactus	0	0	1	0.3	1	0.5	0	0	1	0.8	3	1.6	1.88	8.20	0.00	0.00	0.60	5.56	13.76
Total											**180**	**186.1**	**22.92**	**99.98**	**1.08**	**100.00**	**10.80**	**101.86**	**301.41**

DE = Density, **RDE** = Relative Density, **DO =** Dominance, **RDO** = Relative Dominance, **FR =** Frequency, **RFR** = Relative Frequency, IV = Important Value

Phenology for plant community of *Aerva javanica* L. at Wadi Maleil – Qalwa Province – Al Baha region is accounted in Table 3. The dominant plant associates are *Punica granatum, Atriplex repens, Cassia italic, Ocimum hadiense, Artemisia monosperma, Lycium shawii, Acacia nilotica, Ziziphus mucronata, Anisotes trisulcus, Calotropis procera, Leptadenia pyrotechnica*. The highest density recorded to *Aerva javanica* and lowest to *Leptadenia pyrotechnica*, while the highest value of relative density listed to *Aerva javanica* and lowest to *Leptadenia pyrotechnica*. The highest dominant recorded to *Aerva javanica* and lowest to *Ocimum hadiense*, while the highest value of relative dominance listed to *Aerva javanica* and lowest to *Ocimum hadiense*. The highest frequency recorded to *Aerva javanica* and lowest to *Leptadenia pyrotechnica*, while the highest value of relative frequency listed to *Aerva javanica* and lowest to *Leptadenia pyrotechnica*. The highest important value recorded to *Aerva javanica* but lowest is to *Leptadenia pyrotechnica*.

Table 3: Phenology for plant community of *Aerva javanica* L. at Wadi Maleil – Qalwa Province – Al Baha region. (10 m x 10 m)

Quadrate no.	1		2		3		4		5		Total	Total	DE	RDE	DO	RDO	FR	RFR	IV
Plant name	No.	Area	No.	Area	No.	Area	No.	Area	No.	Area	no.	area							
Aerva javanica	11	4.3	18	5.5	9	6.3	17	8.8	9	8.9	64	33.8	1.89	12.63	0.19	19.19	1.00	11.63	43.45
Punica granatum	12	7.5	13	7.9	11	7.1	5	5.5	5	4.3	46	32.3	1.42	9.49	0.18	18.18	1.00	11.63	39.30
Atriplex repens	3	3.3	0	0	2	1.9	2	4.1	0	0	7	9.3	0.75	5.01	0.05	5.05	0.60	6.98	17.04
Cassia italica	1	0.8	0	0	2	2.1	0	0	0	0	3	2.9	1.03	6.88	0.02	2.02	0.40	4.65	13.55
Ocimum hadiense	1	0.9	0	0	0	0	1	0.9	0	0	2	1.8	1.11	7.42	0.01	1.01	0.40	4.65	13.08
Artemisia monosperma	1	1.3	8	2.5	9	3.3	7	4.8	1	4.9	26	16.8	1.55	10.36	0.09	9.09	1.00	11.63	31.08
Lycium shawii	1	1.1	2	2.3	15	12.4	1	1.2	4	4.4	23	21.4	1.07	7.15	0.12	12.12	1.00	11.63	30.90
Acacia nilotica	2	2.1	4	3.9	11	10.8	0	0	2	1.9	19	18.7	1.02	6.88	0.11	11.11	0.80	9.30	27.29
Ziziphus mucronata	2	2.4	2	2.2	10	9.9	0	0	2	2.1	16	16.6	0.96	6.42	0.09	9.09	0.80	9.30	24.81
Anisotes trisulcus	3	4.2	3	4.3	1	0.1	0	0	0	0	7	8.6	0.81	5.14	0.05	5.05	0.40	4.65	14.84
Calotropis procera	0	0	0	0	0	0	3	3.4	3	4.1	6	7.5	0.80	5.14	0.04	4.04	0.40	4.65	13.83
Leptadenia pyrotechnica	0	0	0	0	3	4.5	0	0	0	0	3	4.5	0.67	4.48	0.03	3.03	0.20	2.33	9.84
Total											225	175.8	14.96	99.63	0.99	89.99	8.60	100.01	299.66

DE = Density, **RDE** = Relative Density, **DO =** Dominance, **RDO** = Relative Dominance, **FR =** Frequency, **RFR** = Relative Frequency, IV = Important Value

Status of for plant community of *Cassia acutifolia* Mill at Wadi Khedran – Qalwa Province – Al Baha region is listed in Table 4. Different variations in healthy, threatened and died are presented. The highest death of plant communities is recorded in *Cassia acutifolia* community (Table 4). Status of plant community of *Calotropis procera* L. at Wadi Rash – Qalwa Province – Al Baha region is listed in Table 5. Different variations in healthy, threatened and died are presented. The highest death of plant communities is recorded in *Leptadenia pyrotechnica* community (Table 5). Status of plant community of *Aerva javanica* L. at Wadi Maleil – Qalwa Province – Al Baha region is accounted in Table 6. Different variations in healthy, threatened and died are presented. The highest death of plant communities is recorded in *Cassia italica* community (Table 6).

Table 4: Status of for plant community of *Cassia acutifolia* Mill. at Wadi Khedran – Qalwa Province – Al Baha region. (10 m x 10 m)

Quadrate no.	1			2			3			4			5		
Plant name	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died
Cassia acutifolia	1	3	1	6	3	1	0	9	7	1	0	8	4	0	9
Citrullus colocynthis	0	3	1	4	1	0	0	0	0	0	0	2	6	0	0
Aerva javanica	5	3	3	2	3	5	0	7	6	4	0	3	4	0	7
Terminalia chebula	8	2	2	5	2	1	12	1	1	14	2	2	21	1	0
Calotropis procera	6	0	9	8	4	0	9	3	1	3	1	6	3	1	9
Acacia ehrenbergiana	5	0	0	2	6	0	0	1	0	3	1	4	1	0	0
Lycium shawii	5	0	7	3	4	0	7	3	5	3	3	2	3	5	7
Cassia italica	7	0	3	8	1	0	3	1	0	4	0	1	1	0	3
Artemisia monosperma	0	1	1	0	1	1	0	1	1	1	0	1	1	0	1
Haplophyllum tuberculatum	0	3	0	0	2	0	0	3	3	0	0	2	0	0	3
Anisotes trisulcus	0	1	0	0	1	0	0	1	1	0	0	1	0	0	1
Leptadenia pyrotechnica	0	1	0	0	1	0	0	1	1	0	0	1	0	0	1
Ziziphus mucronata	2	1	0	3	2	0	0	1	0	1	1	0	0	1	0
Tribulus terrestris	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Atriplex repens	0	0	0	0	0	0	0	0	0	1	1	1	0	0	3
Aloe sabaea	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0
Rhanterium epapposum	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0

The life form distribution of plants growing in arid regions is closely related with topography and landform [6, 34 -36]. The Tehamah plateau in the rain-shadow of the Tuwayq Escarpment in the south western Saudi Arabia has different wadis [37]. Mangal is a mature wadi characterized by its wide, deep valley-fill deposits, and well defined channels cutting older rocky limestone formations. The wadi ecosystem is divided into a number of habitats discernible on the ground of the soil thickness and plant cover. The vegetation is featured for the appearance of many annuals. 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 [3, 6, 24, and 38].

Floristic analysis indicated that the synanthropic species (e.g. *Bassia eriophora*, *C. dactylon*, *Prosopis juliflora*, *Salsola imbricata* and *Tamarix nilotica*) are rare or completely absent in Wadi Khedran, indicating low human impact. However, these species have been recorded as common in a few other wadis and depressions (e.g. Raudhas) in the Tehamah region [3, 5, 8, 26, 27 and 39]. The presence of *A. oerfota*, a rare shrub with restricted distribution and *Maerua crassifolia*, an endangered tree [37], in the study area, can be considered as a positive sign that Wadi Khedran is one of the few areas in the Tehamah region with less human impact.

The life form spectrum reflects a typical desert flora, the majority of species being therophytes and Chamaephytes (about 72%). These results agree with the spectra of vegetation in desert habitats in other parts of Saudi Arabia [2, 12, 13, 14, 39, 40, 41and 42]. Life forms of desert plants are also closely related with topography [6, 19, 34-36, 38, 43]. It may also be stated that the Saharo Arabian species which are restricted in their distribution to the south western strip of Saudi Arabia are more abundant in habitats of more favorable micro-environmental conditions and those providing better protection [35, 39, 43, 44]. Besides high percentage of Saharo Arabian species in the study area, there are several other chorotypes attaining considerable values. This is due to the fact that the south western region contains most of the rocky habitat types of the Peninsula and covers a wide range of bioclimatic zones. The south western region falls within the transition zone from the Somalia-Masai regional center of endemism at low and middle altitudes to the Afromontane archipelago-like center of endemism at high altitudes, and above the tree line even taxa of the Mediterranean region and Irano-Turanian phytochorion are present [20, 35, 43-46]. Among the five vegetation groups in Wadi Khedran ecosystem, characterized by *Cassia italica* Mill has clear separation with dominated by *Acacia ehrenbergiana* Hayne, *Atriplex hortensis* L., *Anisitus risoolaus* and *Aerva javanica*. On the other hand, the groups I and II are less separated because they are characterized by mixed communities of shrubs, chasmophytes and grasses. In Saudi Arabia, [3,25, 47 and 48] recognized several plant associations, some of which are comparable to those of the present study (e.g. *Acacia ehrenbergiana* Hayne, *Atriplex hortensis* L., *Anisitus risoolaus* and *Aerva javanica* which is comparable to that identified in neighboring countries [6, 29, 49]. 2010). The sand dune group A. monosperma has analogous with association recognized by [47], at Al-Thumamah sandy habitats.

Communities in stony plateau and rocky outcrop slope in Wadi Rash, as recognized by [48] are, however, less comparable in Wadi Maleil, which may be due to the variations in climate and topography?*L. shawii* community inhabits the flat stony wadi plateau which consists of notches and shallow drainage runnels. *A. oerfota* community of cliff, chasmophytic shrubby and grassy species inhabits the outcrops of rocky slopes. Then comes the community of *A. raddiana–R. stricta* composed of dense woody and sparse short lived perennial species inhabits the main wide channel of the wadi bed. On the other hand, the wadi Rash, the sand dunes inhabited by adapted *A. monosperma* community.

Table 5: Status of plant community of *Calotropis procera* L. at Wadi Rash – Qalwa Province – Al Baha region. (10 m x 10 m)

Quadrate no.	1			2			3			4			5		
Plant name	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died
Calotropis procera	8	0	4	3	0	0	0	1	0	3	0	0	4	6	4
Cassia italca	3	0	6	7	0	0	0	1	0	1	0	0	1	4	0
Aerva javanica	8	0	4	3	0	0	0	1	0	3	0	0	4	6	4
Acacia tortilis	6	0	1	5	0	4	7	1	0	8	4	0	9	4	6
Cassia acutifolia	1	0	4	1	0	6	0	0	0	2	6	0	0	1	4
Leptadenia pyrotechnica	3	1	6	3	1	4	6	4	0	3	4	0	7	1	1
Anisotes trisulcus	3	1	4	1	0	1	1	6	0	8	1	0	3	4	1
Acacia ehrenbergiana	3	3	2	3	5	2	5	2	1	8	0	0	7	1	0
Calotropis procera	4	0	1	1	0	1	0	1	1	0	1	1	0	1	1
Salvadora persica	6	0	2	0	0	3	0	3	0	0	2	0	0	3	3
Artemisia monosperma	1	0	1	0	0	1	1	0	1	1	0	1	1	0	1
Ocimum hadiense	2	0	0	6	0	0	3	1	0	1	0	0	2	0	0
Ziziphus mucronata	1	1	0	1	1	0	1	0	0	2	0	0	4	0	0
Rhanterium epapposum	0	0	0	1	0	0	1	0	0	3	0	0	3	0	0
Euphorbia cactus	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0

Table 6: Status of plant community of *Aerva javanica* L. at Wadi Maleil – Qalwa Province – Al Baha region. (10 m x 10 m)

Quadrate no.	1			2			3			4			5		
Plant name	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died	Healthy	Threatened	Died
Aerva javanica	11	1	4	10	1	1	9	0	2	1	6	0	5	1	0
Punica granatum	0	3	6	0	4	0	0	0	0	0	4	0	0	0	0
Atriplex repens	0	1	4	0	1	0	0	1	4	0	1	0	0	1	4
Cassia italica	0	2	1	0	0	0	0	0	6	0	0	0	0	0	6
Ocimum hadiense	0	3	1	0	4	0	0	0	4	0	4	0	0	0	4
Artemisia monosperma	3	1	4	3	1	0	6	0	1	3	0	0	7	0	1
Lycium shawii	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Acacia nilotica	0	0	1	0	0	0	4	0	0	0	0	0	0	0	1
Ziziphus mucronata	9	2	4	11	1	1	6	4	1	5	0	0	5	0	0
Anisotes trisulcus	1	0	6	1	0	0	4	0	0	1	0	0	8	1	1
Calotropis procera	3	0	4	0	0	0	1	1	0	1	1	0	0	0	0
Leptadenia pyrotechnica	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0
Calotropis procera	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Soil characteristics

Characters for soil supporting plant communities at wadi Kedrane in Al Baha region are recorded in Tables 7. The species richness was positively correlated with organic matter (0.321) and clay (0.342), and negatively with total cover, EC and sand being 0.342, 0.321 and 0.222, respectively (Table 7). The species cover was positively correlated with pH (0.333) and sand (0.422), and negatively with organic matter, clay, silt and K contents being 0.232, 0.231, 0.434 and 0.453, respectively (Table 7). The species concentration of dominance was positively correlated with Mg (0.455) and Na (0.323), and negatively with the species relative evenness being 0.333 and clay being 0.544 (Table 7). The species evenness was positively correlated with pH, EC and clay being 0.345, 0.301 and 0.321, respectively and negatively with Mg, Na and N being 0.234, 0.325 and 0.543, respectively (Table 7).Characters for soil supporting plant communities at three wadi Rash in Al Baha region are recorded in Tables 8. The species richness was positively correlated with organic matter (0.435) and clay (0.211), and negatively with total cover, EC and sand being 0.543, 0.343 and 0.332, respectively (Table 8). The species cover was positively correlated with pH (0.111) and sand (0.333), and negatively with organic matter, clay, silt and K contents being 0.324, 0.251, 0.554 and 0.555, respectively (Table 8). The species concentration of dominance was positively correlated with Mg (0.422) and Na (0.222), and negatively with the species relative evenness being 0.333 and clay being 0.544 (Table 8). The species evenness was positively correlated with pH, EC and clay being 0.232, 0.101 and 0.121, respectively and negatively with Mg, Na and N being 0.234, 0.125 and 0.143, respectively (Table 8). Characters for soil supporting plant communities at wadi Maleil in Al Baha region are recorded in Table 9. The species richness was positively correlated with organic matter (0.443) and clay (0.231), and negatively with total cover, EC and sand being 0.234, 0.231 and 0.332, respectively (Table 9). The species cover was positively correlated with pH (0.432) and sand (0.324), and negatively with organic matter, clay, silt and K contents being 0.333, 0.341, 0.345 and 0.564, respectively (Table 9). The species concentration of dominance was positively correlated with Mg (0.435) and Na (0.421), and negatively with the species relative evenness being 0.333 and clay being 0.544 (Table 9). The species evenness was positively correlated with pH, EC and clay being 0.215, 0.325 and 0.328, respectively and negatively with Mg, Na and N being 0.417, 0.319 and 0.526, respectively (Table 9).

Table 7: Characters for soil supporting plant communities at Wadi Khedran – Qalwa Province – Al Baha region.

Characters	pH	EC (mS/cm)	Organic matter (%)	Sand (%)	Clay (%)	Silt (%)	Ca ppm	Fe ppm	K ppm	Mg ppm	Na ppm	N ppm	S ppm
Healthy	7.7	3	2.6	50.1	22.2	27.7	1.9	0.6	0.4	1.9	0.7	0.5	2.7
Threatened	7.9	2	1.6	50.1	22.2	27.7	0.9	0.5	0.3	0.6	0.6	0.5	0.9
Died	7.4	1	0.5	50.1	22.2	27.7	0.6	0.3	0.2	0.3	0.2	0.2	0.5

Table 8: Characters for soil supporting plant communities at Wadi Rash – Qalwa Province – Al Baha region.

Characters	pH	EC (mS/cm)	Organic matter (%)	Sand (%)	Clay (%)	Silt (%)	Ca ppm	Fe ppm	K ppm	Mg ppm	Na ppm	N ppm	S ppm
Healthy	7.5	3	2.1	40.4	25.2	34.4	1.2	0.1	0.3	1.4	0.2	0.7	2.2
Threatened	7.4	2	2.0	43.1	22.2	34.7	0.5	0.1	0.3	1.1	0.2	0.6	1.5
Died	7.1	1	1.9	45.1	24.2	30.7	0.9	0.3	0.1	0.9	0.2	0.2	0.4

Table 9: Characters for soil supporting plant communities at Wadi Maleil – Qalwa Province – Al Baha region.

Characters	pH	EC (mS/cm)	Organic matter (%)	Sand (%)	Clay (%)	Silt (%)	Ca ppm	Fe ppm	K ppm	Mg ppm	Na ppm	N ppm	S ppm
Healthy	7.0	3	2.1	45.1	22.2	32.7	1.8	0.1	0.4	1.1	0.2	0.2	2.1
Threatened	7.9	2	2.1	47.1	23.2	29.7	1.5	0.1	0.3	0.9	0.2	0.3	1.1
Died	7.4	1	1.1	43.1	24.2	32.7	1.1	0.3	0.2	0.3	0.2	0.5	0.8

Of particular interest is soil, an important component of the nutrient cycle; it serves as a major reservoir of essential nutrients and an important long-term repository for carbon. The SOM is formed from the combination and decomposition of plant and animal detritus turn affects the long-term health and productivity of forested systems. For example, forest management practices that leave organic residues rather than removing them will have less of an impact on the system nutrient cycling [50, 51]. Little is known about changes in SOM with above-ground of wadis. [52] Found that root exudation increases when wheat plants are exposed to O_3 for 20-30 days. They hypothesized that increased root exudation, despite less carbohydrate transport to roots of desert exposed plants, is due to inadequate substrate availability for membrane maintenance and repair in root tissues. Increased root exudation should stimulate rhizosphere bacteria, and ultimately lead to stimulation of other food web organisms. Consistent with this hypothesis, was the increased CO_2 efflux with increased levels of soil organic matter in soils of plants exposed to desrert environment found in other studies [53]. Bacterial and fungal biomass also increased in soils of plants exposed to the same habitat. [54] Examined the effect of climate change variables on soil organic C quality and suggested that favor high molecular weight in soil and more aromatic quality of C. Also, [55] found that field respiration and microbial biomass C were lower under desert conditions, while death quotient and respiration maintenance increased under the same conditions.

Correlation analysis in the present study indicates that the species diversity (richness and evenness) is positively correlated with increasing organic matter, clay pH and EC. These factors may reflect the degree of wadi bed maturation in the study area [56]. On the other hand, species diversity decreased with increasing Mg, Na, N, EC, sand and species cover (which correlates positively with pH and sand). In such cases, most of the total cover is accounted by one or two species (e.g. the community of *A. monosperma*) that can apparently make the best use of available resources as a result of their high competitive capacities under environmental stress. Similar correlations were reported by [40, 57-59].

Conservation Needs More Analysis

Need for more research/experiments/studies to find the main causes for the problems, to know some other examples, to combat similar problems of seed dispersal information and of tree-top/canopy ecology. The following needs were also found from the workshop participants and from stakeholder interviews; Well-planned research projects; Funding for new research center/infrastructure; Reviewing traditional natural resource use and peoples' life style; Conservation, Techniques and Management Systems; Better management systems (e.g. zoning systems, improvement of forest management, extraction and collection fee on dead trees); Need for more female trees for propagation; Creation of artificial rain; Tissue culture technique for micro-propagation; Protection measures from livestock, and fire Increase in protected areas; Biological control of insects and micro-organisms; Monitoring systems; Participatory Conservation; Public awareness campaign; Organization of human activity, including social groups and NGOs; Cooperation with local people, and boy scouts' activity; Creation of appreciation of juniper (environmental) services; Library for visitors; Restoration and Reforestation Activities; Extensive reforestation (re-planting)activities; Rehabilitation of ecosystems; Nursery to obtain more seedlings; Strategy, Planning and Collaboration.

Consider wider spectrum of vision: including the entire Sarawat mountains, Yemen & Oman; More international collaboration; Cooperation with all government bodies; Need for total care and interest in of the environmental management program, not; only for juniper conservation; Need for planning of strategic management; Need for biodiversity convention, national strategy and national committee; Legal and Enforcement Issues; Need for strong laws and regulations to control human activities; Improvement of implementation of legislation, and enforcement; Establishment of preventive measures to cut trees (e.g. public policy); Increase in protected areas; Facility/Infrastructure Development; Need monitoring facilities and systems (at the forested areas); Publishing center (for material making); Library for visitors; Education center; Visitor centers for researchers and students; Visitor centers for tourists; More research centers in forested areas; Nursery to obtain more seedlings; Implementation; Need action and Environmental Education and Environmental Public Awareness Activities.

CONCLUSION

The correlation analysis in the present work indicates that the species diversity (richness and evenness) is positively correlated with increasing organic matter, clay pH and EC. These factors may reflect the degree of wadi bed maturation in the study area [56]. In spite of, the species diversity decreased with increasing Mg, Na, N, EC, sand and species cover (which correlates positively with pH and sand). In such cases, most of the total cover is accounted by one or two species that can apparently make the best use of available resources as a result of their high competitive capacities under environmental stress.

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