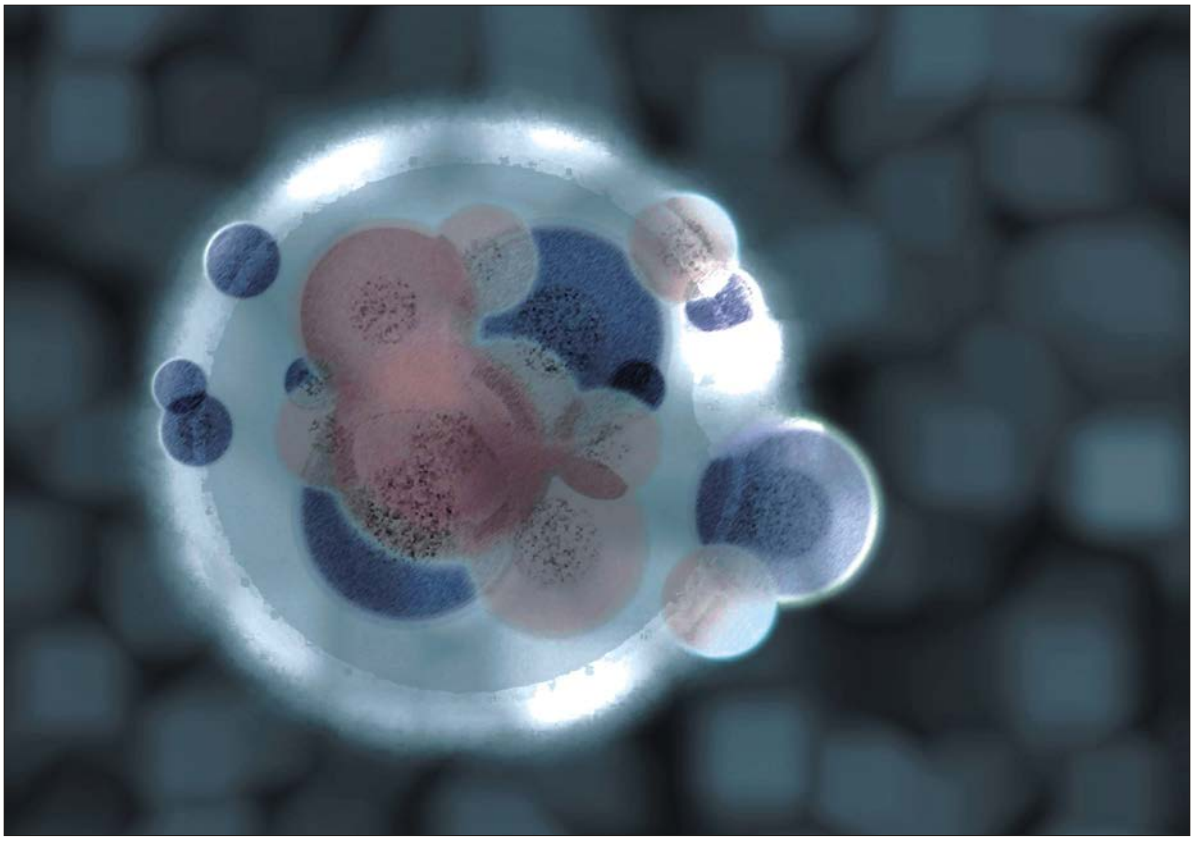

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Community Composition of Major Vegetations in the Coastal Area of Al-Uqair, Saudi Arabia in Response to Ecological Variations

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Abstract: The vegetation characteristics of Al-Uqair coastal area is the major focus of the present study. The studied area is located 55 miles dues south of Dhahran in the eastern province of Saudi Arabia. Three different localities in the study area were ecologically described. The vegetation parameters of the recorded species including density, frequency and abundance with respect to climate and soil characteristics of each habitat were studied. Recorded species were 29 different species with definite community type representing each locality. The major plant species of the first locality representing Al-Uqair coastal strip are *Halopeplis perfoliata*, *Arthrocnemum macrostachyum* and *Halocnemum strbilaceum*. The second locality is dominated with *Suaeda vermiculata* while the third locality which represented the inland extension of the study area is dominated with *Haloxylon persicum*, *Salsola maritima*, *Anabasis setifera* and *Zygophyllum* sp.

Key words: Soil, vegetation, sabkha, salt-marshes

INTRODUCTION

Due to the expansion of dry-lands and rapid increasing of salt-affected regions in the Kingdom of Saudi Arabia, a number of strategies are being considered in an attempt to achieve the most promising economic returns from these salt-lands. Salinity affects plants in several ways and may be associated with a decline in plant growth shoot biomass and water availability and an excessive ion accumulation that produces an equivalent reduction in the nutritive quality of the plants.

Al-Uqair is 55 miles dues south of Dhahran. It lies about 50 miles northeast of the fertile oasis of Al-Hassa and its main city Hofuf on the eastern shore of the Arabian Gulf, on a straight line between the oasis and the island state of Bahrain. The history of Al-Uqair is multi-faceted. The irrigation channels north of Al-Uqair could be the abandoned city of the eastern Saudi Province. It is believed that artesian wells of interconnected streams and lakes draining north eastward toward the Arabian Gulf above Al-Uqair (Mandaville and Grimsdale, 1980; Al-Zarah, 2008).

The desert plant species usually survive under severe drought conditions with minor changes in their water potential. Drought avoiders must mountain a high water potential when exposed to an external water stress (Abd El-Ghani and Amer, 2003). Capon (2005) studied the composition of the plant communities along a floodplain area and indicated that the floodplain plant species are structured primarily on a gradient of broad flood frequency and their distribution varies along the studied area. There was a gradual zonation of plant community composition with observation of temperate and tropical floodplain vegetation zonation.

Halophytes occur in and along the shores of the oceans, seas, gulfs and in certain low-land flats in arid areas where salt can accumulate on the soil surface (sabkhas or salt flats). The salt marshes are associated with lands which characterized by a shallow water table and wide range of salinity. The salt marsh vegetation varies widely in their salinity tolerance. Though many halophytic species appear to grow in/along gulf water but the rain in some areas dilute the soil water to the extent that the actual salinity level is far lower and alter the structure of the vegetation in the ecosystem (English *et al*., 2005). Sabkha is a body of saline water whose level and composition are controlled by the hydrological, geological and climatic conditions of the area. It is defined as a flat area that liable to a periodic inundation and evaporite deposition being formed and developed in response to the surrounded environment. Al Hurban and Gharib (2004) classified sabkha in the Arabian Peninsula into coastal and inland sabkha and proposed that restricts sabkha to shallow basin limited to marginal marine settings which associated with the formation of sand of variable sizes mixed with carbonate mud and scattered crystal of gypsum covered by salts that is formed during flooding.

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In Saudi Arabia, sabkha exists in many locations. It occurs in certain areas of the Eastern Province of the country and in the well-populated cities along the Red Sea (Ibrahim and Jibril, 2005). Due to the water loss from soil and the arid climate of the Saudi Arabia, the halophytic vegetation appear to be highly specialized to salt and well developed by more than 20 community types depending on the prevailing of the environmental conditions such as climate, soil characteristics, elevation above sea level and sea influences (Zahran, 1983).

The behavior of littoral salt marshes which are subjected to maritime influences showed highly specialized growth mechanisms in their tolerance to salt (Youssef *et al*., 2003). They constitute an azonal vegetation for which the soil constitution is primarily decisive but the climate is not wholly without significance (Walter, 1977). Occurrence of the plant species and their growth reflect the distribution of the plant population in nature. Shaltout *et al*. (1996) stated that difference in environmental conditions, resources and disturbance are a few of many other factors that influence the abundance, appearance and distribution of the vegetation in the Eastern Province of Saudi Arabia. Youssef (2001) and Mossalam (2007) reported in their vegetation studies that the distribution of different plant life forms depends mainly on the soil properties and the climatic factors of the areas they studied. Farghali and Zareh (2005) investigated that the vegetation composition and the distribution of plant species of central coastal lowlands of eastern Saudi Arabia were affected by atmospheric, edaphic conditions as well as topography.

Shaltout *et al*. (2003) studied the vegetation of different coastal habitats in the Saudi Arabia and reported that each area in study could be differentiated into three main ecosystems: littoral salt marshes, coastal plain and inland zone. The substratum of the area of land bordering the Arabian Gulf is saline and favors the growth of salt-tolerant plants. The coastal plain dominated by halophytic communities, while the inland zone is characterized by sediments which are not saline and dominated by glycophytic and xerophytic plants (Zahran and Mashaly, 1991). There are several changes which are caused by direct or indirect effects of salinity on the morphology and growth of different plant communities. Under saline growth conditions, many processes related to ion movement in the plant are activated including exclusion, accumulation and compartmentation, which have repercussions on plant mineral composition (Guerrero-Rodriguez, 2006).

Recently, Al-Uqair is considered as one of the most important and active harbor which was constructed and passes by Al-Jishah town and will support economic development of Al-Hassa oasis. The present study presents the floristic and ecological criteria of the major plant species in three localities of Al-Uqair coastal area in the Eastern Province of Saudi Arabia in relation to their soil conditions during 2006.

MATERIALS AND METHODS

The present study was carried out during 2006 on the vegetation of three different coastal sites of Al-Uqair which is located in the Eastern Province of the Kingdom of Saudi Arabia. Al-Uqair is situated between 25°38′ and 25°40′ Northern latitude and 50°12′ and 50°13′ Eastern longitude (Fig. 1). The three selected sites are: coastal strip closed to the Arabian Gulf of latitudes N 25°40.037′ and E 050°12.581′ (Location 1), coastal zone which is situated 400 m West of the shoreline of latitudes N 25°39.549′ and E 050°12.947′ (Location 2) and inland extension of the Arabian Gulf; the coastal plain of latitudes N 25°38.936′ and E 050°13.066′ (Location 3).

Climatic data of the study area for the period January to December 2006 was obtained from the nearest weather station of the Department of Meteorology and Civil Aviation, Dammam weather station, Saudi Arabia. Altitude was determined using a Global Positioning System (GPS) at various localities in the area under investigation.

Soil samples were collected as a profile at a depth of 0-25 cm from each locality. Granulometric characteristics for the different soil samples were analyzed according to Jackson (1967) and Wilde *et al*. (1979). The soil Electrical Conductivity (EC) of the soil saturated paste was determined according to Richards (1954) and expressed as dS m^{-1}. The soil reaction (pH) was determined in saturated soil paste using Fischer's pH meter according to Jackson (1967). Soil analyses including total soluble salts (%), organic carbon (%), chlorides (g 100 g^{-1} dry wt.) and sulphates (g 100 g^{-1} dry wt.) were determined in the 1:5 soil extract as described by Jackson (1967) and Wilde *et al*. (1979). Sodium, potassium and calcium were determined in the 1:5 soil extract photometrically as described by Stewart (1974) and were expressed as (g 100 g^{-1} dry wt.) Magnesium was determined in the 1:5 soil extract using atomic absorption spectrophotometer as described by Stewart (1974) and their values expressed as (g 100 g^{-1} dry wt.).

The plant species were identified with the helpful references of Mandaville (1965, 1990), Täckholm (1974), Migahid (1996) and Batanouny (1979). Floristic composition together with the recurrence (occurrence of the species in the studied quadrats of one location,

% and = R) and recurrence index (recurrence in quadrats of all the three locations, as a percentage of occurrence = RI) were calculated for each species as indicated by Kershaw (1973). Vegetation parameters were measured and analyzed by using the belt transect method within each of the three localities of the coastal area of Al-Uqair using the quadrat method (Braun-Blanquet, 1964; Misra, 1980). These species parameters included: Absolute Density (AD), Absolute Frequency (AF), Absolute Abundance (AA), Relative Density (RD), Relative Frequency (RF) and Relative Abundance (RA). The sum of the relative values gave the important value index (IVI) for the different plant species in each locality depended largely upon the variations in other environmental factors such as elevation, the nature of soil surface and climatic factors.

RESULTS AND DISCUSSION

The study area and climate: The coastal area of Al-Uqair is relatively large and of great importance to Al-Hassa oasis and its main city of Al-Hofuf on the eastern shore of the Arabian Gulf. Artesian wells fed a series of interconnected streams and lakes draining North Eastward toward the Arabian Gulf above Al-Uqair. Three different coastal localities of Al-Uqair were studied of latitudes N 25°40.037′ and E 050°12.581′, N 25°39.549′ and E 050°12.947′ and N 25°38.936′ and E 050°13.066′, respectively. Al-Uqair lies about 55 miles due South of Dammam and 50 miles Northeast of the fertile oasis of Al-Hassa on the east coast of the Arabian Gulf, on a straight line between the oasis and the Island State of Bahrain. Modern map place Al-Uqair at the harbor and shallow lagoon the fort was built next to (Fig. 1).

The climate of the area under investigation is tropical and arid with hot summer and relatively cold winter. The mean monthly values of minimum and maximum air temperature, rainfall and relative humidity are clearly shown in Table 1 which covering the period from January to December 2006. The period from June to October was completely rainless. There are wide variations during the winter period ranged from 1.6 to 5.2 mm month^{-1} during the period of January and December reaching the maximum value of 6.9 mm month^{-1} during March (Table 1). The irregularity of rainfall is pronounced and common for all arid regions (El-Demerdash *et al*., 1994). Rainfall over the coastal area of the Arabian Gulf is sparse and occurs sporadic and often very localized. A particular location

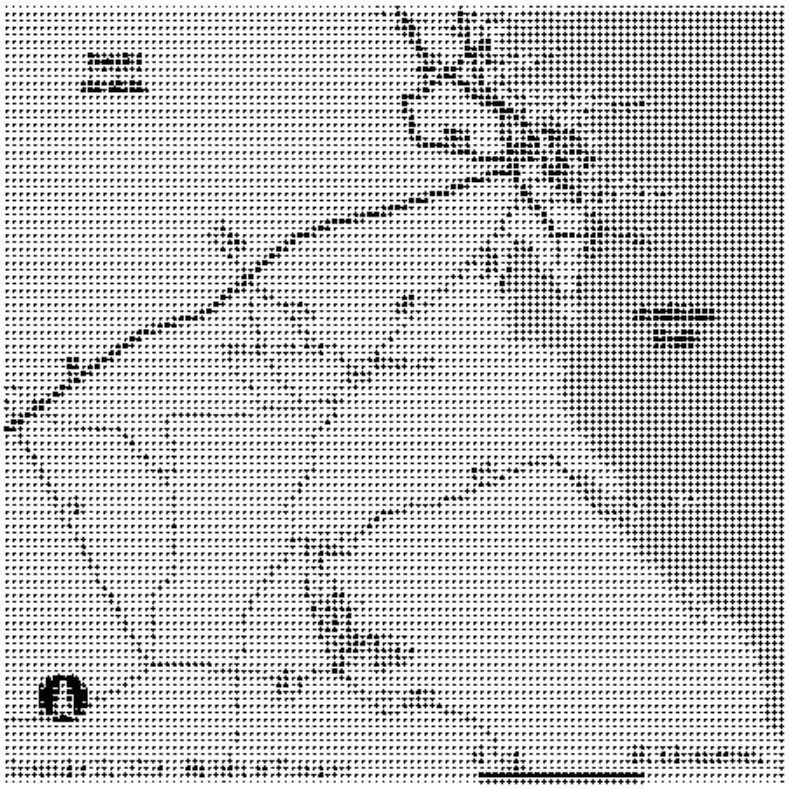

Fig. 1: Location map of Al-Uqair coastal area, Arabian Gulf, Saudi Arabia

Table 1: Mean monthly values of temperature (°C), rainfall (mm month^{-1}) and relative humidity (%) of Dammam for the period January-December 2006

Month	Temperature (°C)			Rainfall (mm month^{-1})	Relative humidity (%)
	Mean	Min	Max		
January 2006	15.0	8.00	22	5.2	58
February 2006	16.5	10.0	23	5.1	56
March 2006	21.5	13.0	28	6.9	61
April 2006	22.0	21.0	33	4.7	62
May 2006	30.5	23.0	38	1.6	61
June 2006	33.5	25.0	42	0.0	67
July 2006	34.0	26.0	42	0.0	77
August 2006	34.5	26.0	43	0.0	79
September 2006	30.5	22.0	39	0.0	64
October 2006	26.0	18.0	34	0.0	60
November 2006	21.0	13.0	29	1.8	56
December 2006	16.0	10.0	22	4.7	53

Table 2: Granulometric analysis, electrical conductivity (EC) and pH of the soil profiles collected from three localities of Al-Uqair area

Location	Altitude (Above the sea level)	Granulometric analysis (%)				Texture class	EC (dS m^{-1})	pH
		Gravels	Coarse sand	Fine sand	Silt and clay			
Coastal strip closed to the Arabian Gulf	3 m	3.2	12.9	46.4	37.5	Fine sand	1.39	7.83
Coastal zone (400 m west of the shoreline)	4 m	1.5	15.4	70.0	13.1	Fine sand	0.65	7.78
Inland extension of the Arabian Gulf (the coastal plain)	4 m	1.0	05.2	51.6	42.2	Fine sand	0.35	7.72

may receive no rain for months or years, then it experiences a brief heavy rainfall which may not be repeated for a similar lengthy period (Zahran and Younes, 1990). The same findings were observed in the rainfall of Al-Uqair coastal area. Regarding temperature, data indicate that the summer months (June, July and August) were the hottest months while those of winter (January, February and December) were the coldest ones for the whole studied area. The monthly mean temperature reached a maximum of 34.5°C in August and a minimum of 15°C in January. The relative humidity of the study area were greatly varied and ranged between 53-79% during the different months. The months July and August were the hottest and the most humid ones (Table 1). Many investigators have discussed the climate of the desert and coastal areas of Saudi Arabia (Zahran and Younes, 1990; Migahid, 1996; Youssef, 2001; Mossalam, 2007; Al-Kahtani *et al*., 2007).

Soil characteristics of the study area: Soil characteristics are the main factors influencing plant growth, cover and distribution of the plant communities. Several investigators have found that there is a relationship between vegetation and soil features (Youssef, 2001; Youssef *et al*., 2003; Farghali and Zareh, 2005; Milad, 2006; Mosalam, 2007; Morsy, 2007; Badel and Mishra, 2007; Al-Zarah, 2008). From Table 2, it is evident that the texture of the soil samples of the all studied profile is sandy. The fine sand fractions constitute the major constituents of the soil; however, coarse sand fractions are relatively low. The amount of gravels recorded the lowest values reaching the minimum of 1% in location 3 (inland extension of the Arabian Gulf, the coastal plain). Silt and clay fractions attained relatively high values in the 3 studied localities. It is observed from the repeated visits to the area that the soil of locality 1 (coastal strip closed to the Arabian Gulf) is always wet with high amounts of water and dark in color compared with the other 2 localities. It has the same characteristics of sabkha. The values of the Electrical Conductivity (EC) varied between the different three localities and ranged between 0.35-1.39 dS m^{-1}. Results of the soil reaction values (Table 2) were slightly alkaline in the different localities. There were no differences between values of pH for the studied area. The Total Soluble Salts (TSS) varied between 9.3-18.2% in the three studied locations (Table 3). The highest value of TSS (18.2%) was attained in locality 1 (coastal strip closed to the Arabian Gulf). The Organic Carbon (OC) of the studied localities is poor in their contents that not exceed 0.21%. Generally, organic content shows no remarkable variations between the different localities. This content was increased in the inland extension of the coastal plains of Al-Uqair area compared with the other two studied localities (Table 3). It is obvious from the chemical analysis of the soil for the different localities that chloride ions are the dominant ions in the desert soil. The data obtained indicate that soils of the coastal localities 1 and 2 recorded higher values of 8.62 and 5.40 g 100 g^{-1} dry wt. For sulphates, they recorded the highest values in locality 1 (2.54 g 100 g^{-1} dry wt.) and the lowest value in locality 3 (1.74 g 100 g^{-1} dry wt.). The cations of the studied area were dominated by Na^+ followed by Ca^{2+} and K^+, whereas the Mg^{2+} ion was the least. All the analyzed cations behaved in the

Table 3: Total soluble salts (TSS), organic carbon (OC) and mineral composition of the soil profiles collected from three localities of Al-Uqair area

Location	Altitude (Above the sea level)	TSS (%)	OC (%)	Cl^-	SO_4^{-1}	Na^+	K^+	Ca^{2+}	Mg^{2+}
				g 100 g^{-1} dry wt.					
Coastal strip closed to the Arabian Gulf	3 m	18.2	0.05	8.62	2.54	4.27	0.42	0.86	0.32
Coastal zone (400 m west of the shoreline)	4 m	12.1	0.18	5.40	1.68	2.62	0.31	0.63	0.26
Inland extension of the Arabian Gulf (the coastal plain)	4 m	9.3	0.21	2.92	1.74	2.34	0.28	0.51	0.24

Table 4: List of plant species recorded in Al-Uqair coastal area with their families, life forms, localities, Recurrence (R) and Recurrence Index (RI) based on the record in 5 studied quadrats 2×2 m^2 in each location of: 1 (coastal strip closed to the Arabian Gulf), 2 (coastal zone which is situated 400 m west of the shoreline) and 3 (inland extension of the Arabian Gulf; the coastal plain). The life forms are: Ph, phanerophytes; Ch, chamaephytes; G, geophytes (cryptophytes, hemi-cryptophytes and helophytes); Th, therophytes and P, parasites

Family	Plant species	Life form	Locality 1	2	3	R	RI
Chenopodiaceae	*Halopeplis perfoliata* (Forssk.)Bunge Ex Asch.	Th	5	-	-	5	33.3
Chenopodiaceae	*Arthrocnemum macrostachyum* (Moric) Moris and Delponte	Th	4	-	-	4	26.7
Chenopodiaceae	*Halocnemum strbilaceum* (Pall.) M.Bieb.	Th	4	-	-	4	26.7
Chenopodiaceae	*Seidlitzia rosmarinus* Ehrenb. Ex Bunge	Th	3	-	-	3	20.0
Chenopodiaceae	*Chenopodium album* L.	Th	2	-	-	2	13.3
Chenopodiaceae	*Suaeda vermiculata* Forssk. ex J.F. Gmel.	Ch	3	2	-	5	33.3
Chenopodiaceae	*Salsola arabica* Botsch	Ch	1	3	-	4	26.7
Chenopodiaceae	*Salsola maritima* (L.) Dum.	Ch	1	3	2	6	40.0
Chenopodiaceae	*Haloxylon persicum* Boiss	Th	-	2	3	5	33.3
Chenopodiaceae	*Cornulaca monacantha* Del.	Ch	-	2	-	2	13.3
Chenopodiaceae	*Anabasis setifera* Moq.	Th	-	2	2	4	26.7
Zygophyllaceae	*Zygophyllum coccinum* L.	Th	2	5	2	9	60.0
Zygophyllaceae	*Zygophyllum simplex* L.	Th	1	3	2	6	40.0
Zygophyllaceae	*Nitraria retusa* (Forssk.) Ascher	Th	3	2	-	5	33.3
Zygophyllaceae	*Fagonia indica* Burm	Ch	-	3	2	5	33.3
Zygophyllaceae	*Fagonia ovalifolia* Hadidi	Ch	-	2	2	4	26.7
Plumbaginaceae	*Limonium axillare* (Forssk.) Kuntze	Ch	-	2	-	2	13.3
Cyperaceae	*Cyperus conglomeratus* Rottb.	G	-	3	-	3	20.0
Boraginaceae	*Heliotropium ramosissimum* DC	Ch	-	3	-	3	20.0
Boraginaceae	*Arnebia hispidissima* (Lehm) DC	Th	-	2	3	5	33.3
Poaceae	*Panicum turgidum* Forssk.	G	-	2	3	5	33.3
Poaceae	*Pennisetum divisum* (Gmel.) Henr.	Ch	-	2	2	4	26.7
Poaceae	*Lolium multiflorum* Lam.	Th	-	-	1	1	6.70
Poaceae	*Lolium rigidum* Gaudin	Th	-	-	2	2	13.3
Asclepiadaceae	*Leptadenia pyrotechnica* (Forssk.) Decne	Ph	-	1	2	3	20.0
Convolvulaceae	*Convolvulus glomeratus* Choisy	Th	-	-	3	3	20.0
Fabaceae	*Melilotus indica* L.	Th	-	1	2	3	20.0
Polygonaceae	*Rumex vesicarius* L.	Th	-	2	3	5	33.3
Euphorbiaceae	*Euphorbia granulata* Forrsk.	Th	-	1	2	3	20.0

same trend, the highest values attained in locality 1 (4.27, 0.86, 0.42 and 0.32 g 100 g^{-1} dry wt., respectively) while the lowest values of 2.34, 0.51, 0.28 and 0.24 g 100 g^{-1} dry wt,. respectively were recorded in the inland extended locality 3 (Table 3). The variations observed in the soil analyses of Al-Uqair study area are mainly due to the differences in the nature and the geomorphologic characters (Morsy, 2007).

Vegetation analysis of the study area: A total of 29 plant species belonging to 11 families were recorded. Family zygophyllaceae attained the highest value of RI (60%). Chenopodiaceae was represented as the second major family recorded RI of 40% (Table 4). There were seven families represented by single species each. The life forms of the studied plants exhibit a wide variation. Therophytes were the predominant life form followed by chamaephytes, geophytes and phanerophytes. The same findings were recorded by Mosalam (2007) and Al-Zarah (2008). The studied area of Al-Uqair may be distinguished into three main localities: 1) Coastal strip of Al-Uqair area which extended very close to the Arabian Gulf with saline flats known as sabkha which is bounded at the tidal zone by a narrow raised beach line of calcareous sand. On the inland side of the beach area, different community types are extended which dominated by *Halopeplis perfoliata* and the co-dominant species are *Arthrocnemum macrostachyum* and *Halocnemum strbilaceum* and the associated species are *Seidlitzia rosmarinus*, *Chenopodium album*, *Suaeda vermiculata*, *Salsola arabica*, *Salsola maritima*, *Zygophyllum coccinum*, *Zygophyllum simplex* and *Nitraria retusa* (Table 4, 5).

Coastal zone of Al-Uqair which is situated at 400 m West of the shoreline of the Arabian Gulf and dominated by *Suaeda vermiculata*. The co-dominant species are *Salsola arabica*, *Salsola maritima*, *Haloxylon persicum*

Table 5: Floristic composition of plant species recorded in location 1 of Al-Uqair; coastal strip closed to the Arabian Gulf, based on the record in 5 studied quadrats 2×2 m^2

Plant species	AD	AF	AA	RD	RF	RA	IVI
Halopeplis perfoliata (Forssk.)Bunge Ex Asch.	2.5	100	5.6	35.3	20	29.0	84.3
Arthrocnemum macrostachyum (Moric) Moris and Delponte	1.4	80	3.1	19.0	16	16.1	51.1
Halocnemum strbilaceum (Pall.) M.Bieb.	1.3	80	2.9	17.7	16	15.0	48.7
Seidlitzia rosmarinus Ehrenb. Ex Bunge	0.5	60	1.7	6.8	12	8.8	27.6
Chenopodium album L.	0.5	60	1.4	6.8	12	7.3	26.1
Suaeda vermiculata Forssk. ex J.F. Gmel.	0.3	40	1.3	4.1	8	6.7	18.8
Salsola arabica Botsch	0.2	20	0.8	2.7	4	4.1	10.8
Salsola maritima (L.) Dum.	0.2	20	0.8	2.7	4	4.1	10.8
Zygophyllum coccinum L.	0.15	20	0.6	2.1	4	3.1	9.2
Zygophyllum simplex L.	0.1	10	0.7	1.4	2	3.6	7.0
Nitraria retusa (Forssk.) Ascher	0.1	10	0.4	1.4	2	2.1	5.5

AD: Absolute density, AF: Absolute frequency, AA: Absolute abundance, RD: Relative density, RF: Relative frequency, RA: Relative abundance and IVI: Importance value index

Table 6: Floristic composition of plant species recorded in location 2 of Al-Uqair coastal zone, 400 m west of the shoreline, based on the record in 5 studied quadrats 2×2 m^2

Plant species	AD	AF	AA	RD	RF	RA	IVI
Suaeda vermiculata Forssk. ex J.F. Gmel.	3.3	100	6.2	16.8	20.8	19.2	56.8
Salsola arabica Botsch	2.6	60	4.3	13.2	12.5	13.3	39
Salsola maritima (L.) Dum.	2.2	40	3.1	11.2	8.3	9.6	29.1
Haloxylon persicum Boiss	1.8	40	2.6	9.1	8.3	8.1	25.5
Cornulaca monacantha Del.	1.8	20	2.7	9.1	4.2	8.3	21.6
Anabasis setifera Moq.	1.6	20	2.1	8.1	4.2	6.5	18.8
Zygophyllum coccinum L.	1.3	20	2.1	6.6	4.2	6.5	17.3
Zygophyllum simplex L.	1.3	20	1.7	6.6	4.2	5.3	16.1
Nitraria retusa (Forssk.) Ascher	0.6	10	1.4	3.1	2.1	4.3	9.5
Fagonia indica Burm	0.4	10	0.8	2.1	2.1	2.5	6.7
Fagonia ovalifolia Hadidi	0.4	10	0.7	2.1	2.1	2.2	6.4
Limonium axillare (Forssk.) Kuntze	0.5	10	0.6	2.5	2.1	1.9	6.5
Cyperus conglomeratus Rottb.	0.5	10	0.8	2.5	2.1	2.5	7.1
Heliotropium ramosissimum DC	0.3	20	0.6	1.5	4.2	1.9	7.6
Arnebia hispidissima (Lehm) DC	0.1	10	0.6	1.5	2.1	1.9	5.5
Panicum turgidum Forssk.	0.2	20	0.6	1	4.2	1.9	7.1
Pennisetum divisum (Gmel.) Henr.	0.2	10	0.4	1	2.1	1.3	4.4
Leptadenia pyrotechnica (Forssk.) Decne	0.3	20	0.3	1.5	4.2	1	6.7
Melilotus indica L	0.1	10	0.3	1.5	2.1	0.8	4.4
Rumex vesicarius L	0.1	10	0.2	1	2.1	0.8	3.9
Euphorbia granulata Forrsk.	0.1	10	0.2	1	2.1	0.8	3.9

AD: Absolute density, AF: Absolute frequency, AA: Absolute abundance, RD: Relative density, RF: Relative frequency, RA: Relative abundance and IVI: Importance value index

and *Cornulaca monacantha* and the associated species are *Anabasis setifera*, *Zygophyllum coccinum*, *Zygophyllum simplex* and *Nitraria retusa* (Table 4, 6).

Inland extension of Al-Uqair area on the Arabian Gulf which is formed mainly of the desert plains and extends west beyond the inland sandy part of Al-Uqair-Al Hofuf Road. *Haloxylon persicum* is the dominant species of the locality and the co-dominant types are *Salsola maritima, Anabasis setifera*, *Zygophyllum coccinum* and *Zygophyllum simplex*. Many other species are associated within the site such as *Fagonia indica*, *Fagonia ovalifolia*, *Arnebia hispidissima*, *Panicum turgidum*, *Pennisetum divisum*, *Lolium multiflorum*, *Lolium rigidum*, *Leptadenia pyrotechnica*, *Convolvulus glomeratus*, *Melilotus indica*, Rumex vesicarius and *Euphorbia granulate* (Table 4, 7).

The characteristic species of the locality 1 are: *Halopeplis perfoliata*, (AF, 100% and IVI, 84.3%), *Arthrocnemum macrostachyum* (AF, 80% and IVI, 51.1%) and *Halocnemum strbilaceum* (AF, 80% and IVI, 48.7%). The other associate species have relatively lower IVI values. However, *Zygophyllum coccinum*, *Zygophyllum simplex* and *Nitraria retusa* recorded the lowest values of IVI; 9.2, 7.0 and 5.5%, respectively (Table 5). According to the total soluble salts concentration of the soil, *H. perfoliata* is the dominant plant species at the first locality which is the closest one to the Gulf. (Abd El-Maksoud, 1987; Youssef, 1988).

The dominant species in locality 2 of the studied area of Al-Uqair is *Suaeda vermiculata* which has AF of 100%, AA of 6.2% and IVI of 56.8% among all the observed species (Table 6). The co-dominant characteristic species are *Salsola arabica* (AF, 60% and IVI, 39.0%), *Salsola maritima* (AF, 40% and IVI, 29.1%), *Haloxylon persicum* (AF, 40% and IVI, 25.5%) and *Cornulaca monacantha* (AF, 20% and IVI, 21.6%). The plant abundance within the locality 2 ranged between 0.2-6.2% during the period of study. This community type is floristically related to *Suaeda vermiculata* however, the other associated

Table 7: Floristic composition of plant species recorded in location 3 of Al-Uqair inland extension of the coastal plain of the Arabian Gulf based on the record in 5 studied quadrats 2×2 m^2

Plant species	AD	AF	AA	RD	RF	RA	IVI
Haloxylon persicum Boiss	3.7	100	4.8	17.5	14.9	17.1	49.5
Salsola maritima (L.) Dum.	2.1	80	3.9	10.0	11.9	13.9	35.8
Anabasis setifera Moq.	2.1	80	2.7	10.0	11.9	9.6	31.5
Zygophyllum coccinum L.	1.8	60	2.3	8.5	8.9	8.2	25.6
Zygophyllum simplex L.	1.7	60	2.1	8.1	8.9	7.4	24.4
Fagonia indica Burm	1.4	40	2.1	6.6	6.0	7.4	20.0
Fagonia ovalifolia Hadidi	1.4	40	1.8	6.6	6.0	6.4	19.0
Arnebia hispidissima (Lehm) DC	0.8	20	0.7	3.8	3.0	2.5	9.3
Panicum turgidum Forssk.	1.2	40	1.4	5.7	6.0	4.9	16.6
Pennisetum divisum (Gmel.) Henr.	1.3	40	1.3	6.1	6.0	4.6	16.7
Lolium multiflorum Lam.	0.7	20	0.9	3.3	3.0	3.2	9.5
Lolium rigidum Gaudin	0.6	20	0.7	2.8	3.0	2.5	8.3
Leptadenia pyrotechnica (Forssk.) Decne	0.6	20	0.8	2.8	3.0	2.8	8.6
Convolvulus glomeratus Choisy	0.6	20	0.8	2.8	3.0	2.8	8.6
Melilotus indica L.	0.6	10	0.7	2.8	1.5	2.5	6.8
Rumex vesicarius L.	0.3	10	0.7	1.4	1.5	2.5	5.4
Euphorbia granulata Forrsk.	0.2	10	0.4	1.0	1.5	1.4	3.9

AD: Absolute density, AF: Absolute frequency, AA: Absolute abundance, RD: Relative density, RF: Relative frequency, RA: Relative abundance and IVI: Importance value index

species have ecologically a significant and prominent representation in the same locality. The presence of some shrubs represent an advanced stage of vegetation where the soil is of mixed sand and silt, mostly water born materials.

Locality 3 is floristically dominated with *Haloxylon persicum* species (AF, 100% and IVI, 49.5%). The characteristic co-dominant species *Salsola maritima*, *Anabasis setifera*, *Zygophyllum coccinum* and *Zygophyllum simplex* attained relatively higher values of AF and IVI (AF, 80% and IVI, 35.8%; AF, 80% and IVI, 31.5%; AF, 60% and IVI, 25.6% and AF, 60% and IVI, 24.4%, respectively) as indicated from Table 7. *Haloxylon persicum* is one of the desert perennial herbaceous species that occurred in the sandy soil and is present in numerous stretches of the drainage systems of the studied area. *Haloxylon persicum*, *Anabasis setifera* and *Panicum turgidum* are the most abundant plant species in the third locality. They considered as the pioneer species in the drainage channels of the sandy desert (Kassas and Girgis, 1965). *Zygophyllum coccinum* and *Zygophyllum simplex* are widely distributed plant species in both localities 2 and 3 of Al-Uqair study area. They grow in the coastal land of the Arabian Gulf (Youssef, 2001) and in the inland salt marshes areas (Kassas and Girgis, 1965; Zahran, 1983; Abd El-Maksoud, 1987; Youssef, 1988; Youssef *et al*., 2003).

CONCLUSION

In general we may say that halophytic vegetation characterizes the coastal area of Al-Uqair with widespread grasses and halo-xeric species along the low inland extension of the Arabian Gulf (the coastal plain). The major plant species of the first locality representing Al-Uqair coastal strip are *Halopeplis perfoliata*, *Arthrocnemum macrostachyum* and *Halocnemum strbilaceum*. The *Halopeplis perfoliata* which inhabited the saline depression of the coastal area had a high records of density, frequency and abundance. This could be due to the very high salinity, shallow water table and poor aeration and drainage. The second locality is dominated with *Suaeda vermiculata* while the third locality which represented the inland extension of the study area is dominated with *Haloxylon persicum*, *Salsola maritima*, *Anabasis setifera* and *Zygophyllum* sp. The distribution of species in each group could be related to the degree of salinity of its soil and/or heterogeneity of substrate in the stabilized sandy substratum, which supported the recorded types of halophytic and/or xerophytic species. Similar conclusions of the same findings of vegetation were concluded by Zahran (1983), Abd El-Maksoud (1987), Youssef (1988), Zahran and Younes (1990), Abbadi and El-Sheikh (2002), Youssef *et al*. (2003) and English *et al*. (2005).

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REFERENCES

Abbadi, G.A. and M.A. El-Sheikh, 2002. Vegetation analysis of Failaka Island (Kuwait). J. Arid Environ., 50 (1): 153-165.

Abd El-Ghani, M.M. and W.M. Amer, 2003. Soil-vegetation relationships in a coastal desert plain of Southern Sinai, Egypt. J. Arid Environ., 55 (4): 607-628.

Abd El-Maksoud, A., 1987. Ecological and phytochemical studies on some plants of Salhiya-Ismailia desert area. Ph.D Thesis, Al-Azhar University, Cairo, Egypt.

Al-Hurban, A. and I. Gharib, 2004. Geomorphological and sedimentological characteristics of coastal and inland sabkhas, Southern Kuwait. J. Arid Environ., 58 (1): 59-85.

Al-Kahtani, M.A., A.M. Youssef and A.A. Fathi, 2007. Ecological studies on Al-khadoud spring, Al-Hassa, Saudi Arabia. Pak. J. Biol. Sci., 10 (22): 4063-4068.

Al-Zarah, A.I., 2008. Chemistry of groundwater of Al-Ahsa Oasis Eastern Region Saudi Arabia and its predictive effects on soil properties. Pak. J. Biol. Sci., 11 (3): 332-341.

Badel, M. and B.B. Mishra, 2007. Characterization of some soils of Jijiga plain, Ethiopia. J. Food Agric. Environ., 5 (3-4): 416-424.

Batanouny, K.H., 1979. Vegetation along the Jeddah-Mecca road pattern and process as affected by human impact. J. Arid Environ., 2 (1): 21-30.

Braun-Blanquet, J., 1964. Plant Sociology. Translated by G.D. Fuller and H.S. Conard, McGraw Hill Book Co., Inc., New York.

Capon, S.J., 2005. Flood variability and spatial variation in plant community composition and structure on a large arid floodplain. J. Arid Environ., 60 (2): 283-302.

El-Demerdash, M.A., A.K. Hegazy and A.M. Zilay, 1994. Distribution of plant communities in Tihamah coastal plains of Jazan region, Saudi Arabia. Vegetatio, 112 (1): 141-151.

English, N.B., J.F. Weltzin, A. Fravolini, L. Thomas and D.G. Williams, 2005. The influence of soil texture and vegetation on soil moisture under rainout shelters in a semi-desert grassland. J. Arid Environ., 63 (1): 324-343.

Farghali, K.A. and M.M. Zareh, 2005. Phytosociological survey on the central coastal lowlands of Eastern Saudi Arabia. Arab Gulf J. Sci. Res., 23 (4): 165-172.

Guerrero-Rodriguez, J.D., 2006. Growth and nutritive value of Lucerne (*Medicago sativa* L.) and Melilotus (*Melilotus albus* Medik.) under saline conditions. Ph.D Thesis, School Agric. Food and Wine, The University of Adelaide, Australia.

Ibrahim, A.A. and B.Y. Jibril, 2005. Chemical treatment of sabkha in Saudi Arabia. Desalination, 175 (1): 205-210.

Jackson, M.L., 1967. Soil Chemical Analysis. Perintice-Hall of India Private, New Delhi, India.

Kassas, M. and W.A. Girgis, 1965. Habitats and communities in the Egyptian desert, VI. The units of a desert ecosystem. J. Ecol., 53 (1): 719-729.

Kershaw, K.A., 1973. Quantitative and Dynamic Plant Ecology. Edward Arnold Pub. Ltd., London.

Mandaville, J.P., 1990. Flora of Eastern Saudi Arabia. Kegan Paul International London, Jointly with the National Commission for Wildlife Conservation and Development, Riyadh, Saudi Arabia.

Mandaville, J.P., 1965. Notes on the vegetation of Wadi As-Sahba, Eastern Saudi Arabia. J. Bombay Nat. Hist. Soc., 62 (1): 330-332.

Mandaville, J.P. and M. Grimsdale, 1980. The Sumerian Connection, ARAMCO World, March/April.

Migahid, A. M., 1996. Flora of Saudi Arabia. 4th Edn. Riyadh, Saudi Arabia.

Milad, M.M., 2006. Flora study series in Saudi Arabia: A study of the soil of Makkah-Madinah road until Rabigh. Umm Al-Qura Univ. J. Sci. Med. Eng., 18 (1): 13-29.

Misra, R., 1980. Ecology Workbook. Oxford and IBH Publ. O., New Delhi, Bombay.

Morsy, A.A., 2007. Molecular variations of Achillea fragrantissima (Forssk.) SCH. BIP.growing in five Areas of South Sinai. Int. J. Agric. Biol., 9 (1): 11-17.

Mossalam, H.A.M., 2007. Comparative study on the vegetation of protected and non-protected areas, Sudera, Taif, Saudi Arabia. Int. J. Agric. Biol., 9 (2): 202-214.

Richards, L.A., 1954. Diagnosis and Improvement of Saline and Alkali Soils. US Dept. Agric. Handbook, pp: 60.

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. Biodivers. Conserv., 5 (1): 27-36.

Shaltout, K.H., M.G. Sheded, H.F. El-Kady and Y.M. Al-Sodany, 2003. Phytosociology and size structure of *Nitraria retusa* along the Egyptian Red Sea coast. J. Arid Environ., 53 (3): 331-345.

Stewart, E.A., 1974. Chemical Analysis of Ecological Material. Blackwell Sci. Publ., Edinburgh, Mellbourn, Oxford, London.

Täckholm, V., 1974. Student's Flora of Egypt. Cairo Univ. Press, Cairo, Egypt.

Walter, H., 1977. Climate: Chapter 3. In: Ecosystems of the World. I. Wet Coastal Ecosystem, Chapman, V.J. (Ed.). Elsevier Sci. Publ. Co., Amsterdam, pp: 61-67.

Wilde, S.A., R.B. Corey, J.G. Lyer and G.K. Voigt, 1979. Soil and Plant Analysis for Tree Culture. Oxford and IBH Publ. Co., New Delhi, Bombay.

Youssef, A.M., 1988. Ecological studies on the plant communities of the desert area South of Ismailia. M.Sc. Thesis, Ain Shams Univ., Cairo, Egypt.

Youssef, A.M., 2001. Adaptive responses of some halophytes to marine habitat and pollution with crude oil at Al-Sammaliah Island, Abu Dhabi, United Arab Emirates. Az. J. Pharm. Sci., 28 (1): 106-124.

Youssef, A.M., R.A. Hassanein, A.A. Hassanein and A.A. Morsy, 2003. Changes in quaternary ammonium compounds, praline and protein profiles of certain halophytic plants under different habitat conditions. Pak. J. Biol. Sci., 6 (10): 867-882.

Zahran, M.A., 1983. Introduction to Plant Ecology and Vegetation Types of Saudi Arabia. King Abdul-Aziz Univ. Press, Jeddah, Saudi Arabia.

Zahran, M.A. and H.A. Younes, 1990. conservation of plant life in Saudi Arabia. J. King Abdul-Aziz Univ. Sci., 2 (1): 19-41.

Zahran, M.A. and I.A. Mashaly, 1991. Ecological notes on the flora of the Red Sea coastal land of Egypt. Bull. Fac. Sci., Mansoura Univ. Egypt, 18 (1): 251-291.