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PLANT DIVERSITY, DISPERSION, COMMUNITY SIMILARITY, AND VEGETATION DESCRIPTION IN UNITED ARAB EMIRATES. II EASTERN COAST

By

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التنوع البيولوجي النباتي وطرز انتشار النباتات وتشابه العشائر في دولة الامارات العربية المتحدة . (٢) الساحل الشرقي

ممدوح إبراهيم علي العامري

تم عمل دراسات أولية لطرز التجمعات في ثلاث عشائر طبيعية في الساحل الشرقي بدولة الامارات العربية المتحدة هي دبا ، ضدنا ، والفجيرة .

شملت الدراسة قائمة بالأنواع النباتية ومدى وجودها وانتشارها ، علاقة المساحة بتوزيع الأنواع ، الإثراء في التنوع البيولوجي النباتي والتباينية بين الأنواع ومدى التناظر في توزيع الأنواع ، دراسة مؤشرات تشابه العشائر وتناسقها الترتيبي والتحليل الرياضي المجمع والتحليل الرياضي العكسي لهذه العشائر .

أوضحت مؤشرات الانتشار وجود انتشار مرضي للأنواع (مثل العدوى المرضية) وليس منتظماً أو عشوائياً . كانت علاقة توزيع الأنواع النباتية بالمساحة مطابقة لتوزيعات أغلب النظم البيئية الصحراوية وذات معامل علاقة عال . عكست مؤشرات دراسة التشابه في العشائر أفتقار في التشابه بين دبا وضدنا وعدم تشابه بينهم وبين الفجيرة وأكدت دراسة التحليل التجمعي تطابقها مع نتائج هذه المؤشرات .

دلت مؤشرات الإثراء على أن منطقة الفجيرة هي أكثرها ، ومنطقة ضدنا هي أقلها إثراءاً .

Key Words : Plant diversity, Community similarity, UAE, Eastern Coast

ABSTRACT

The vegetation on the eastern coast of UAE was studied in 3 undisturbed sites. Dispersion, species-area, and community similarity were investigated. Cluster analysis and regression correlation were calculated. Diversity parameters used were richness, heterogeneity, and evenness indices, habitat and vegetation patterns are described. Dispersion was more contagious at $P<0.01$ in the three communities. Species-Area were typical of desert ecosystem with high R^2values. Community similarity analysis (5 methods) reflected modest similarity between Diba and Dhadna and dissimilarity with Al-Fujairah. Cluster analysis confirms similarity calculations. Correlation's give poor r-values. Diversity richness in Diba, Al-Fujairah, and Dhadna were 3, 3.9, and 2.6 (Margalef); 1.9, 2.3, and 1.6 (Menhinick), respectively. Heterogeneity and evenness were discussed in details.

INTRODUCTION

The Northern East Coast of the United Arab Emirates that extends along the Gulf of Oman (Map 1, see part I) on 25°05' - 25°45' N, 56°20' - 56°25' E, represents the site of this study. A preliminary study of the vegetation ecology of this area, which has not been fully explored before, is documented in this study. The individualistic concept of Gleason [1] provides a framework of examining a plant community in details with its dynamics in mind[2]. Whittaker [3] named this approach a gradient analysis. The preliminary objective of this work is to obtain data conductive to gradient analysis across the coast. This study includes the dispersion of species, species-area relationships, ecolog-

ical diversity, cluster and regression analysis, and community similarity of Diba, Al-Fujairah, and Dhanda.

MATERIALS AND METHODS

A short description of climate, physiography and soil, habitats and vegetation is provided to give a background for the vegetation patterns of the Eastern Coast.

The plant species were identified with helpful references of Mandiville [4], Cornes [5], Batanouny [6], Migahed [7,8] and Täckholm [9]. Dispersion analysis, diversity indices, community similarity indices, cluster analysis based on quantitative data measurements were applied following the steps in part I. The change along the gradient was represented by the regression analysis and correlation coefficient.

RESULTS AND DISCUSSION

Climate: The studied area represents part of the East Coast, an offshore part extends from 20-40 meters from the Gulf of Oman, thus open to the Indian Ocean regime. Climate is characterized by high temperature with remarkable fluctuations of maxima to minima and scanty rainfall. During night and sometimes during day time before sunset, the relative humidity of 90 to 100% prevails especially during the long summer season. Precipitation in the East Coast of UAE occurs entirely as rainfall, and almost affected by monsoon during summer season, except for a few records in 1981 and 1986 where snow thunder-storms struck the area. Annual rainfall of the East Coast stations is represented in figure 1 (adopted from Dubai International Airport weather booklet). The 19 years averages indicated the range for Al-Fujairah between 12 mm in 1985 to 360 mm in 1983 and reflected modest to poor annual averages in the last few years. Wind speeds for the East Coast (14 years averages) are cited in Table1, (adopted from Dubai International booklet). Data represents wind > 18 knots and sea > 4 feet (f), where the highest record for duration > 24 hours (h) were in February and March and no record in May. The highest records for duration > 24 h and < 48 h were in December and zero or no record in 7 months of the year. The extreme sea > 8 f were in December.

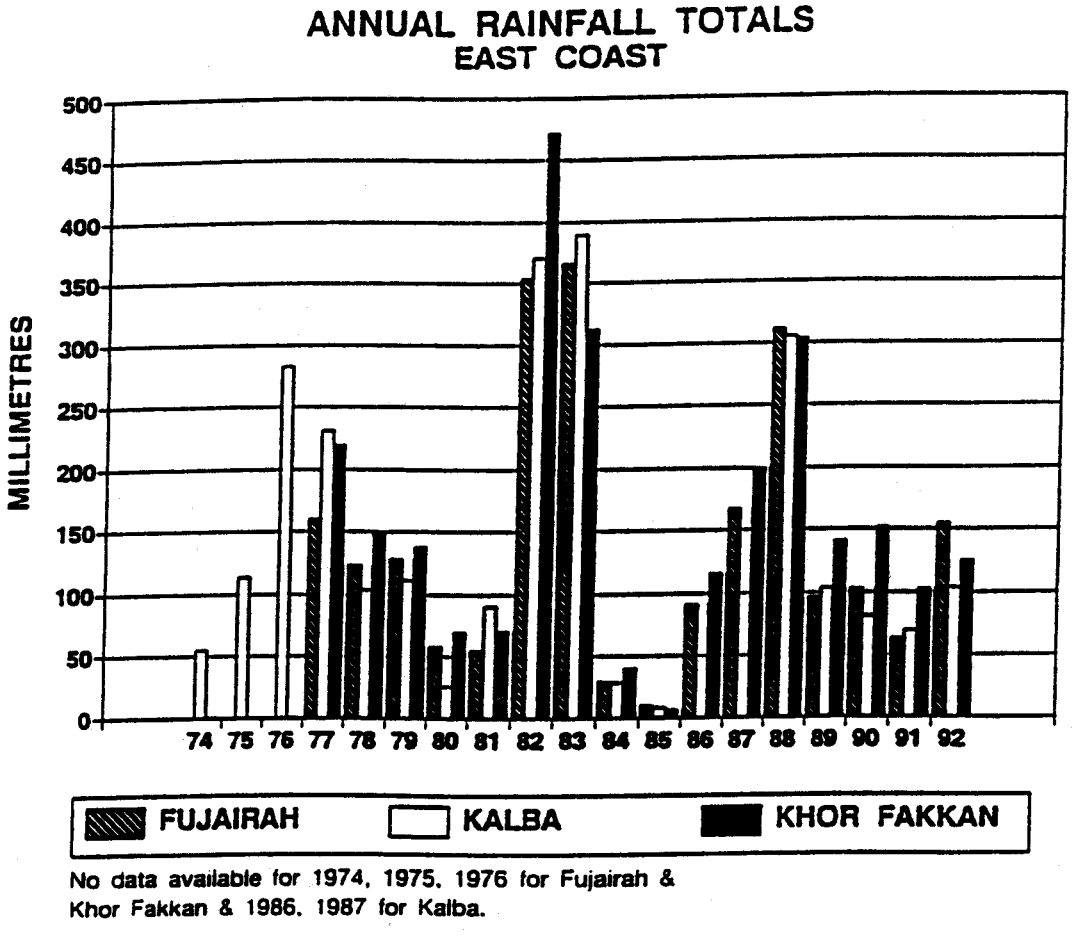

Fig. 1. The annual rainfall for the eastern Coast of UAE

Table 1
Easterly component wind (> 18 knot) and seas (>4 Feet)
for a 14-year period (1979-1992), Dubai UAE.

Item/Month	J	F	M	A	M	J	J	A	S	O	N	D
d* < 24 h	12	19	14	4	0	1	2	6	2	6	4	12
48 h>d< 24 h	2	2	2	0	1	0	0	0	0	0	0	4
d > 48 h	0	0	1	0	0	0	0	0	0	0	0	1
Seas > 4 feet	0	1	0	0	0	0	0	0	1	0	1	4

* d = duration

Physiography and soil: The eastern coastline of UAE runs about 75 kms along the Gulf of Oman, thus, open to the Indian Ocean and follow much of its regime. The western coastline differ ecologically from east coastline because it is open to the Arabian Gulf with different patterns of vegetation and it is not likely to be treated within the same matrices of the eastern sites. The eastern coast consists of a narrow plain, up to about 6 kms wide in the south, dividing the shoreline from the mountains which extend rocky spurs to the sea. The coastal plain become narrower further north apart from the wide alluvial Diba plain. There are no permanent streams along the coast, but at Al-Fujairah and Diba wide seasonal wadis debouch into the sea. Around Al-Fujairah, there is some saline marshland but further north the coast is rocky. Significant passes through mountains occur mainly in Al-Fujairah and partly at Diba.

Habitat and Vegetation Description: The coastline near Diba with the alluvial plain area, characterized by the *Astragalus hamosus-Cornulaca monacantha* community type in the south part; associated species were *Suaeda* sp., *Aeloropus lagopoides,* and *Euphorbia larica.* In the northern part of Diba the community type was dominated by *Zygophyllum simplex - Cyperus conglomeratus* and the co-dominant species were *Cornulaca monacantha, Aeloropus lagopoides, and Euphorbia larica.* In Al-Fujairah the community type was dominated by *Fagonia glutinosa,* and *Astragalus hamosus* on the flat area and gentle slopes with *Euphorbia larica* on the mountain cliffs and ridges; associated species were *Trigonella aurantiaca, Helianthemum lippii,* and *Conyza bonariensis.* Dhadna area is characterized by calcarious deposits in many sites and fine textured soil with crust sometimes in small patches. The community type of Dhanda is dominated by *Fagonia glutinosa* and *Zygophyllum simplex* and co-dominant species were *Ocradenus baccatus* and *Cyperus conglomeratus,* the associated species were *Astragalus hamosus, Trigonella aurantiaca,* and *Cornulaca monacantha.*

Floristic composition: The presented families in the three sites were 13 comparing 29 species and 130 individuals (Table 2). Leguminous species were the highest, represented by 6 species (20.7%) of the total species and about 24.6% of total individuals. *Astragalus hamosus* was the dominant species, with high recurrence index (R.I.) = 93.3%, followed by *Trigonella aurantiaca* (R.I. 53.3%). Chenopodiaceae represented the second major group with 17.2% of total species and 10.8% of total individuals. *Cornulaca monacantha* was co-dominant in two communities (R.I. = 53.3). Zygophyllaceae comprised 13.8% of total species and 17.7% of total individuals; thus reflected good R.I. for some species such as *Fagonia glutinosa* and *Zygophyllum simplex.* Cyperaceae and Poaceae were represented by 10.3% each. *Cyperus conglomeratus* was present in 2 sites with 66.7%. Each of the remaining families were represented by a single species. However, some families have species with high recurrence index: Euphorbiaceae and Resedaceae.

Dispersion Analysis: The dispersions data record showed close mean and median (Table 3) but with high standard deviation around the mean, observed Chi-Square deviated from the expected one. Morisita's index indicated a contagious dispersion ($P<0.01$). High correlation coefficient values on log bases were recorded for the 3 communities (Fig. 2) and reflected typical minimal areas for the desert ecosystem [10,11] with high r^2values though the floristic composition was not rich. In this study richness was poor as area increased from 1m x 1m to 5m x 5m in the 3 sites.

Regression: Based on 3 x and 3 y variables, the data indicated almost perfect negative correlation with poor "r" value among the three communities (Fig. 3). However, t-test indicated that one cannot reject the null hypothesis that species came from the same population at a significant level ($P<0.05$) and there was no significant difference between the 3 encountered areas where species originated from the same population.

Diversity: Whittaker [12] made a distinction between α diversity (number of species diversity within a chosen area or community) and β diversity (difference in species diversity between areas or communities). The latter was our goal in this study. This work focuses on the most common and acceptable standard methods (see Table 4 in Magurran

Table 2

List of families and their species, recurrence (R) and recurrence index (R.I.) based on the record in 5 studied quadrates in each site of Diba, Fujairah, and Dhadna

No	Family	Species	Diba	Fujairah	Dhadna	R	R.I.
1	Leguminosae						
	1- *Acacia ehrenbergiana* Hayne		-	3	-	3	20.0%
	2- *Acacia tortilis* (Forssk.) Hayne		-	2	-	2	13.3%
	3- *Astragalus hamosu* L.		5	5	4	14	93.3%
	4- *Trigonella aurantiaca* Boiss.		-	4	4	8	53.3%
	5- *Ononis reclinata* L.		-	2	-	2	13.3%
	6- *Indigofera articulata* Gouan.		-	3	-	3	20.0%
2	Chenopodiaceae						
	1- *Cornulaca monacantha* Del.		5	-	4	9	60.0%
	2- *Suaeda sp.*		3	-	3	6	40.0%
	3- *Arthrocnemum glaucum* (Del.) Ung. Sternb		1	2	-	2	13.3%
	4- *Haloxylon salicornicum* (Bunge) Botsch		-	3	-	3	20.0%
	5- *Cornulaca sp.*		-	-	2	2	13.3%
3	Zygophyllaceae						
	1- *Fagonia glutinosa* Del.		-	4	5	9	60.0%
	2- *Fagonia ovalifolia* Hadidi var. Pakistanica Ghafour		-	3	-	3	20.0%
	3- *Fagonia bruguieri* DC.		-	2	-	2	13.3%
	4- *Zygophyllum simplex* L.		5	-	5	10	66.7%
4	Cyperaceae						
	1- *Cyperus conglomeratus*		5	-	5	10	66.7%
	2- *Cyperus sp.*		2	-	-	2	13.3%
	3- *Cyperus conglomeratus* Rottb var. aucheri.		2	-	-	2	13.3%
5	Poaceae (Gramineae)						
	1- *Aeloropus lagopoides* (L.) trinex. Thwiates		3	-	-	3	20.0%
	2- *Panicum repens* L.		-	-	3	3	20.0%
	3- *Ergrostis ciliaris* (L.) R. Br.		2	-		2	13.3%
6	Resedaceae			-	-		
	Ochradenus baccatus Del.		2	-	5	7	46.7%
7	Euphorbiaceae						
	Euphorbia larica Boiss.		3	5	-	8	53.3%
8	Polygonaceae						
	Calligonum comosum L' Her		2	-	-	2	13.3%
9	Apocynaceae						
	Rhazya stricta Decne.		-	2	-	2	13.3%
10	Cistaceae						
	Helianthemum lippii (L.) Dum-Cours.		-	3	-	3	20.0%
11	Boraginaceae						
	Arnebia hispidissima (Lehm) DC		-	2	-	2	13.3%
12	Asteraceae (Compositae)						
	Conyza bonariensis (L.) cronquist		-	3	-	3	20.0%
13	Liliaceae						
	Asphodelus sp.		-	-	3	3	20.0%

Table 3

Dispersion analysis for the communities of Diba, Al-Fujairah and Dhadna
(<1 = random, 1 = uniform, and >1 contagious)

Parameter	Computer output
No of species	29
No of individuals	130
1- Mean per sample	13.10000
2- Median	12.57140
3- Variance	69.81160
4- Standard deviation	8.35533
5- variance to mean ratio	5.32812
6- Chi - Square	687.45800
7- Overal Morisita index	1.32812
Conclusion: Dispersion is more contagious than random at $p<0.01$	

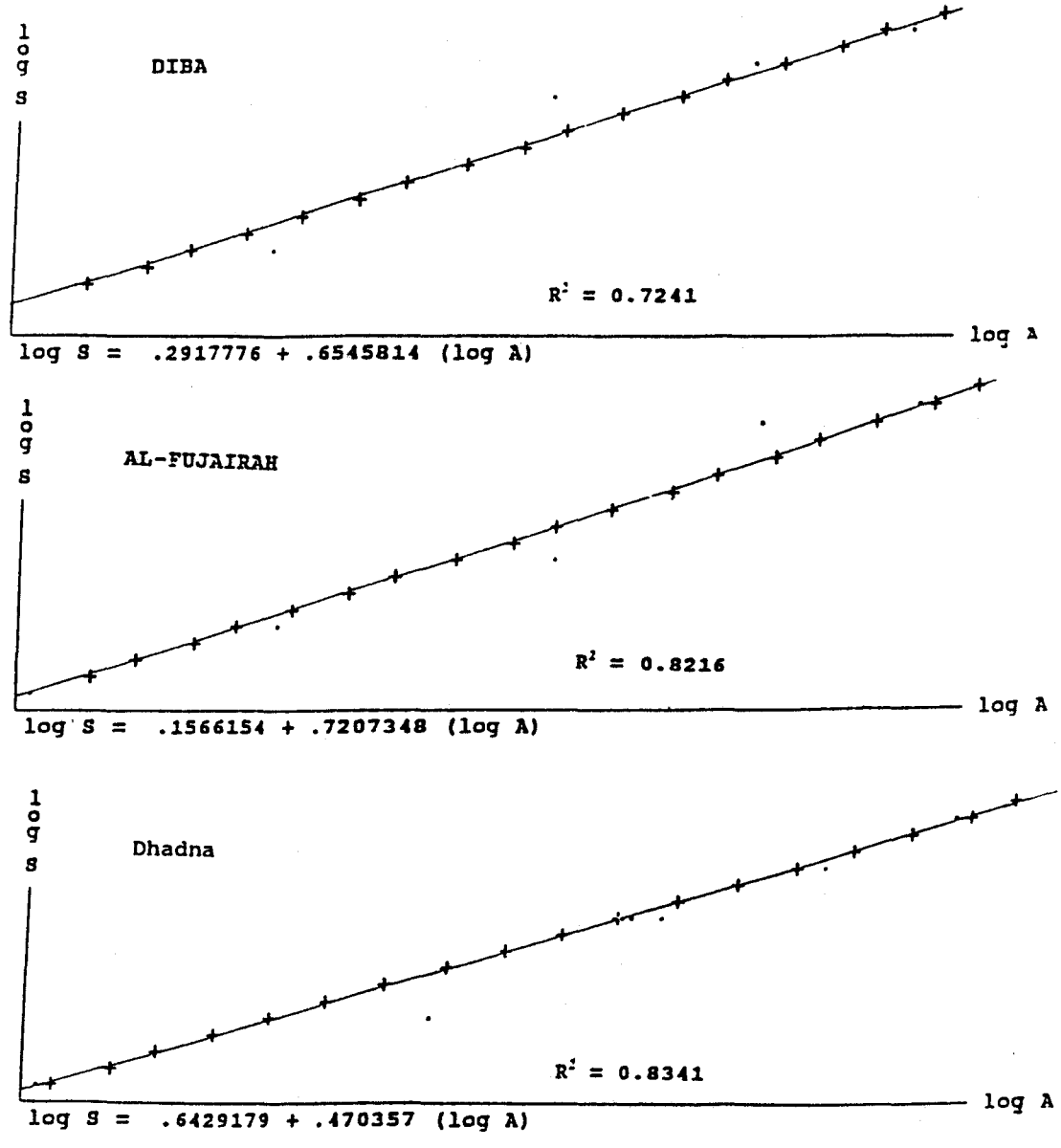

Fig. 2. Species-area relationships for Diba, Al-Fujairah, and Dhadna, with r^2 values

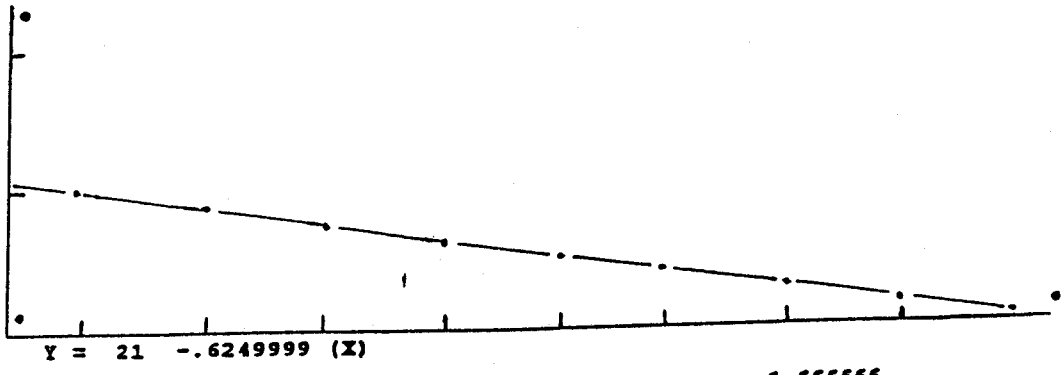

Figure 3. Regression correlation for the areas of Diba, Al-Fujairah, and Dhadna

Table 4
Computed diversity indices in Diba, Al-Fujairah, and Dhadna

Index / community	Diba	Al-Fujairah	Dhadna
A) Richness			
1- No of species	12	16	11
2- Marqalef	3.024	3.875	2.643
3- Menhinick	1.947	2.309	1.658
B) Heterogeneity			
1- Simpson	0.930	0.950	0.924
2- Shannon (H')	2.420	2.720	2.361
3- Hill (NI)	11.250	15.174	10.606
4- Hill (N2)	14.347	20.143	13.139
C) Evenness			
1- Pielou (J')	0.974	0.981	0.985
2- Sheldon	0.938	0.948	0.964
3- Heip	0.932	0.945	0.961
4- Hill evenness	1.275	1.327	1.239
5- Hill modified	1.302	1.351	1.264

text, [2]). Margalef's and Menhinick's indices showed increase in species richness in Dhanda (Table 4). Shannon's index measure degree of heterogeneity and range from 1 (low species richness) to about 3.5 (high species richness). In the 3 studied areas richness was not poor or modest. Hill's indices are modified from Shannon's and Simpson's (see the materials and methods) suggested that as the units for all diversity numbers were the same the difference between the diversity numbers might provided a plausible estimate of evenness. Hill's recorded indices were proportional to Shannon's and Simpson's indices. The recorded Pielou's indices [13] were relatively high and indicated more evenness of the species in their distribution within the studied communities. Al-Fujairah has evenness, in terms of Pielou's and Sheldon's higher than Diba. Heip's index confirmed Pielou's and Sheldon's records and made clear that all the three communities are similar in species even distribution. Hill evenness and Hill modified evenness indices reflected high dominance in Al-Fujairah than Dhadna and the overall dominance was poor.

The community similarity indices and cluster analysis indicated poor similarity between Diba and Al-Fujairah, and between Dhadna and Al-Fujairah (Table 5). A modest similarity recorded between Diba and Dhadna (Table 5.C). These data were confirmed with Morisita's and Horn's indices, where they were only between Diba and Dhadna. However, Jaccard Coefficient showed that some species are common among the communities. Cluster analysis proved that presence of a close relationship between Diba and Dhadna as they have narrower distance compared to others.

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Table 5

Community simlarity indices, cluster analysis, and regression correlation of the communities of Diba, Al-Fujairah and Dhadna

Item / community		Diba	Al-Fujairah	Dhadna
a) Number of species		12	16	11
b) Number of individuals		39	48	43
c) Percent similarity	Diba	-	20.8	54.8
	Al-Fujairah	-	-	25.8
	Dhadna	-	-	-
d) Morisita Index	Diba	-	0.407	0.850
	Al-Fujairah	-	-	0.448
	Dhadna	-	-	-
e) Horn's Index	DIba	-	0.222	0.606
	Al-Fujairah	-	-	0.291
	Dhadna	-	-	-
f) Jaccard coefficient	Diba	-	0.077	0.353
	Al-Fujairah	-	-	0.125
	Dhadna	-	-	-

Proportion of y variation due to x (R^2) = 0.24999
Correlation coefficient (r) = -0.49999
Cluster distance: 1 --------- 3 = 0.394326
1 --- 2, 3 = 0.830542

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