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Contribution to Genesis and Classification of some Soils in the South Valley Region (El-Tarfawi – Debis Extension Area)

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THE STUDY area occupies the eastern part of east Oweinat project and bounded by longitudes 28° 20 and 29° 40 E and latitudes 22° 20 and 23° 30 N. The area embodies many different landscape units, namely, almost flat "sand terrain or deflated plain": undulating "sand terrain or deflated plain": sand dunes rock outcrops and loss hills . it aims to characterize the different soils dominating the various landforms and shedding the light on the possible factors concerning with soil formation. The study aims also to evaluate the taxonomic units, at family level, identify according to us. Taxonomy in terms of their suitability for agriculture development adopting three land evaluation systems.

Soils characteristics are clearly affected by the prevailinghigh temperature and sever wind erosivety - hyper-arid conditions - the nature of soil parent materials and also the nature of the geologic structure. Soils therefore, show no evident to development or horizons formation. Accordingly, six soil association, at family level, belonging to *Typic and lithic* subgroups of *Torripsamments* and *Torriorthents* could be distinguished.

Land evaluation was conducted on bases of the modified Storie Index, PLES – Arid model and land suitability for irrigated agriculture. Accordingly, the soils showed moderate to high suitability for a limited number of crops i.e., wheat barely, onion and alfalfa as it is noticed and realized in agriculture projects and applications in the filed.

Keywards: South valley, Soil classification, Land forms, Land evaluation, Land suitability for crops .

In Egypt, the rapidly increasing population developed a great stress on the limited cultivated land. Therefore, a set of mega national agricultural projects started by the end of the second millennium aiming at realizing optimal utilization of the possible available promising land resources in remote desert regions. These projects would hopefully absorb citizens from the Nile Valley by providing job opportunities that may help resolve the unemployment problem.

In this concern, the National South Valley Development Program aimed to creat new communities in Upper Egypt. The south valley region, which extends

from Toshka in the east to the *vicinity* of El-Oweinat, has been given great consideration as it has an increasing potential for agricultural development depending mainly on the groundwater from the Nubian aquifer.

The current study aims to characterizing the different soil types and sheds some light on their classification and possible potentiality for reclamation.

Physiographic Features

The area under consideration occupies the eastern part of East Oweinat project and extend from Debis in the south to the north of Qaret El Mayet. It is located between longitude 28° 30' and 29° 40' E and latitude 22° 20' and 23° 30' N (Fig. 1). It covers about 9514 km^2.

The area is influenced by hot and dry climatic conditions that are expected to have prevailed during the Holocene and the late Paleistocene times (Pierre, 1989). The maximum air temperature is 38.9° recorded in July, whereas the minimum value is 5.2° recorded in December. Rainfall is rare showing severe aridity. Wind speed averages at 11 km/hr, which means the urgent need for establishing wind breaks to alleviate their expected hazardous effects on grown crops.

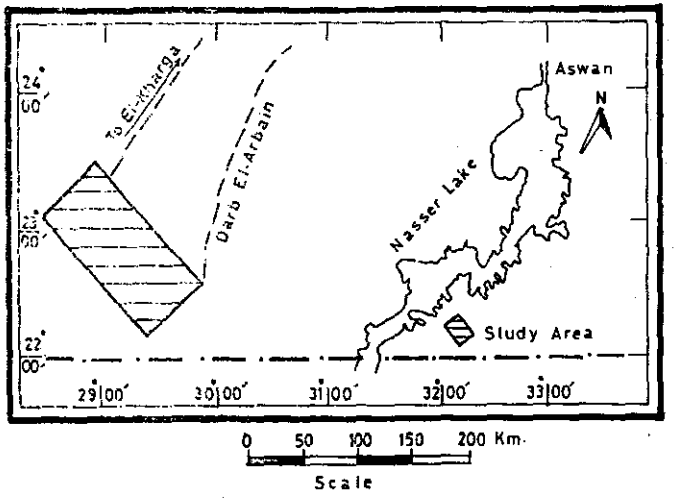

Fig. 1. Key map of the study area.

Lithologically, the surface is occupied by Mezoic sandstone body attributed to the Nubian Sandstone. Nevertheless, Quaternary deposits, represented by sand sheets and sand dunes, overlay the Nubian Sandstone (El Shazly *et al.*, 1977).

Basement exposures, represented by granite mass, are cropping at Qaret El Mayet at the northern part of the study area (plate 1).

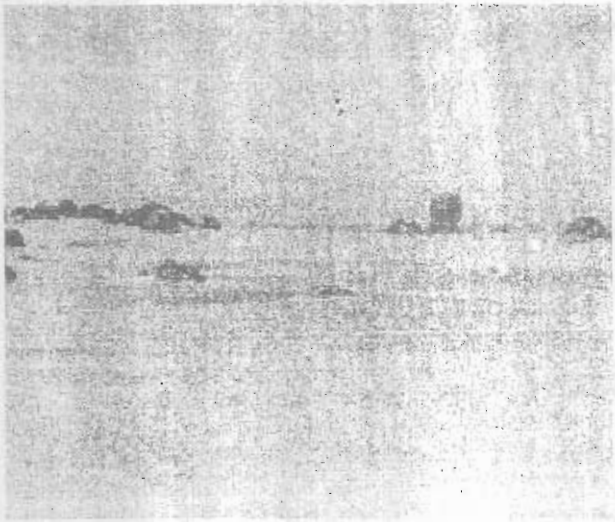

Plate 1. Spheroidally weathered granite masses at Qaret -- El-mayet area.

Regarding the landscape units, the study made by the GBC and DRC (1981) showed that more than twelve units could be identified. In the present study, these landform units could be cut down to only seven; namely (Fig. 2).

1. Mobile inland sand dunes.
2. Almost flat "Sand terrain".
3. Undulating "Sand terrain".
4. Almost flat "deflated plain".
5. Flat-Udulating "deflated plain".
6. Strongly weathered rock land.
7. Isolated hills and rock exposures.

Figure 2 shows that most of the eastern and southern parts of the area are occupied by rock exposures with thin soil cover. On the other hand, sand dunes occur only in a small patch due west. Sand terrain and deflated plain extend along the western side from north to south and possibly be interrupted by small areas of rock outcrops or low hills.

- Ecologically, due to the severe aridity and the rare of precipitation, the natural vegetative cover is nearly absent, except for few uncommon bushes of *Tamarix aphylla**, which grow where fresh ground water exist (plate 2).

*Personal sentific communication with colleagues in Ecology Dept. DRC., Egypt.

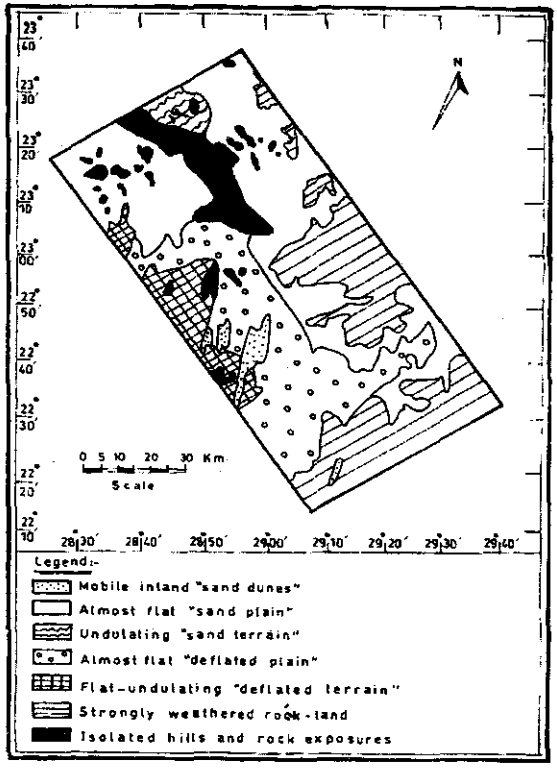

Fig. 2. Physiographic map of El-Tarfewi – Debis extension area.

Hydrologically, the only source of water for irrigation and other purposes is the groundwater. According to El Sayed (2001), there are three water classes within the fresh water zone, namely ultra fresh (< 500 mg/l), fresh water (500-700 mg/l) and fairly fresh water class (> 700 mg/l). Beside the subsurface flow from SW to NE. Further, the author reported that the anticipated, drawdown for land development in the area, will range from 35 to 100 m by the end of 100 years when an area of about 189,000 feddan would be cultivated.

Material and Methods

Twenty five soil profiles, representing the different common landscape units, were carefully examined and morphologically described according to the system outlined by the Soil Survey Staff (1993) (Fig. 3). Soil samples were subjected to some standard physical and chemical analyses, *i.e.,* particle size distribution, total carbonates, organic matter, electrical conductivity, and soil reaction, according to Black (1982).

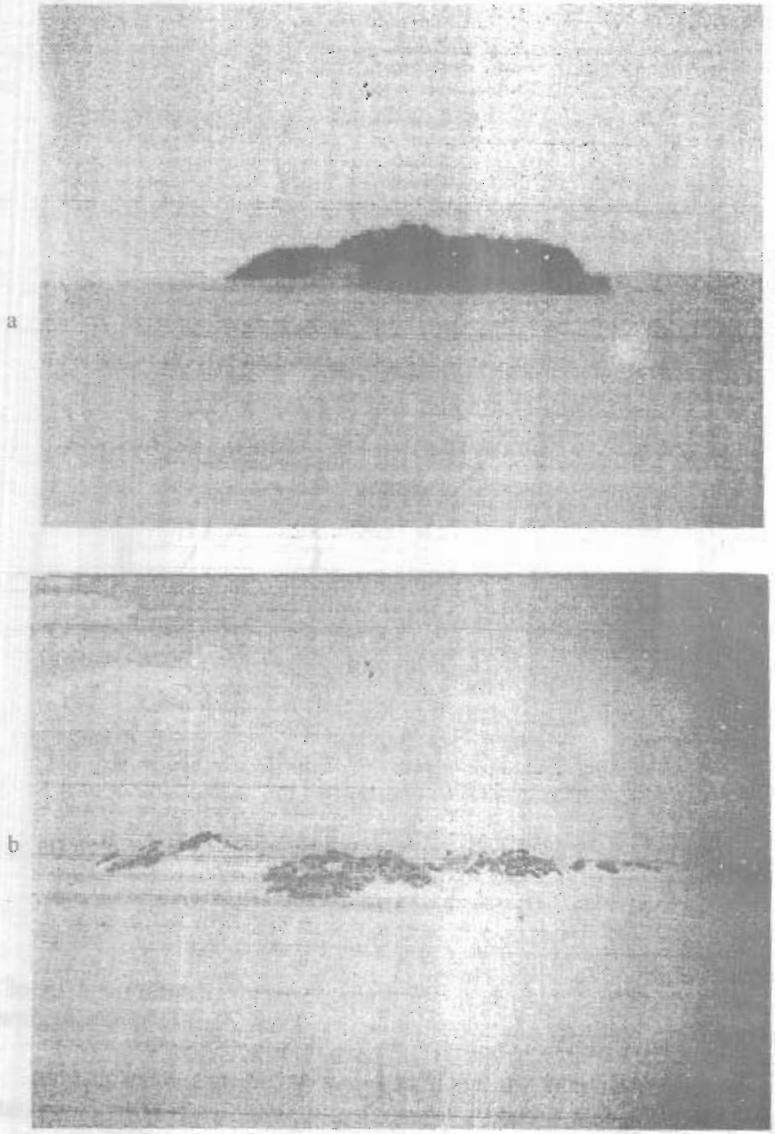

Plate 2. Shows rarity of natural vegetation occurrence except in widely spaced
a - relatively high hillocks
b –low sand mounds.

Soils were taxonomically classified according to Soil Survey Staff (1999). Land productivity class and land suitability for different crops were prescribed applying the PLES model reported by Khalifa (2004).

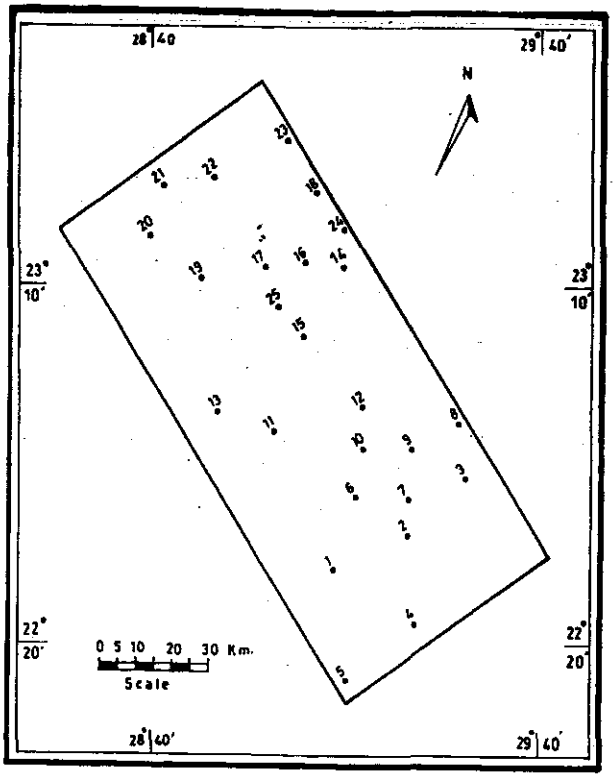

Fig. 3. Soil profile location map.

Results and Discussion

Soil genesis and classification

Reviewing the lithological aspects of the area reveals that the majority of the land surface is occupied by siliceous Nubian Sandstone that might have lime or iron oxides content.

Concerning soil moisture regime, there is a complete absence of precipitation through the whole year indicating that soils have torric moisture regime.

Soil temperature displays a difference of 13° between the mean summer (June, July and August) and mean winter (December, January and February). In addition the mean annual soil temperature is 26.2°. Accordingly, soils have hyperthermic soil temperature regime (Table 1).

Under these circumstances soils are expected to have experienced weak pedogenic processes due to which soil devoid any sign of modification or horizon formation .

On the contrary, geogonic processes are very much pronounced. Physical weathering due to stress within rocks from day and night temperature fluctuation led to the breaking up of the rocks into small fragments, which are the source of gravels and soil material hereafter (Plate 3). Wind erosion is the most influential factor under the prevailing conditions as wind speed ranges between 5.0 and 6.8 m/sec. It is responsible for the formation of "deflated plain". Cumulization of the sand deposit leads to the formation of surface layers of the "sand terrain".

TABLE 1. Soil temperature (at 50cm soil depth) and wind velocity at El-Oweinat area* (mean values).

Months	Soil temperature °C, at 50cm	Wind velocity, (km/hr)
January	16.6	10.0
February	17.7	10.3
March	21.6	11.6
April	26.3	12.3
May	30.4	11.7
June	32.4	13.3
July	33.7	11.2
August	33.9	10.8
September	31.7	13.3
October	29.0	11.9
November	22.3	10.8
December	18.2	9.8

* El-Demerdash *et al.* (1989)

On the basis of Soil Taxonomy, US Soil Survey Staff (1999) the studied soils could be distinguished, at family level, into six associations (Fig. 4).

The following is an account of soil characteristics of taxonomic units identified within the different landscape units, (Tables 2 & 3).

Plate 3. Physical weathering as the main cause of rock outcrops disintegration to channery fragments .

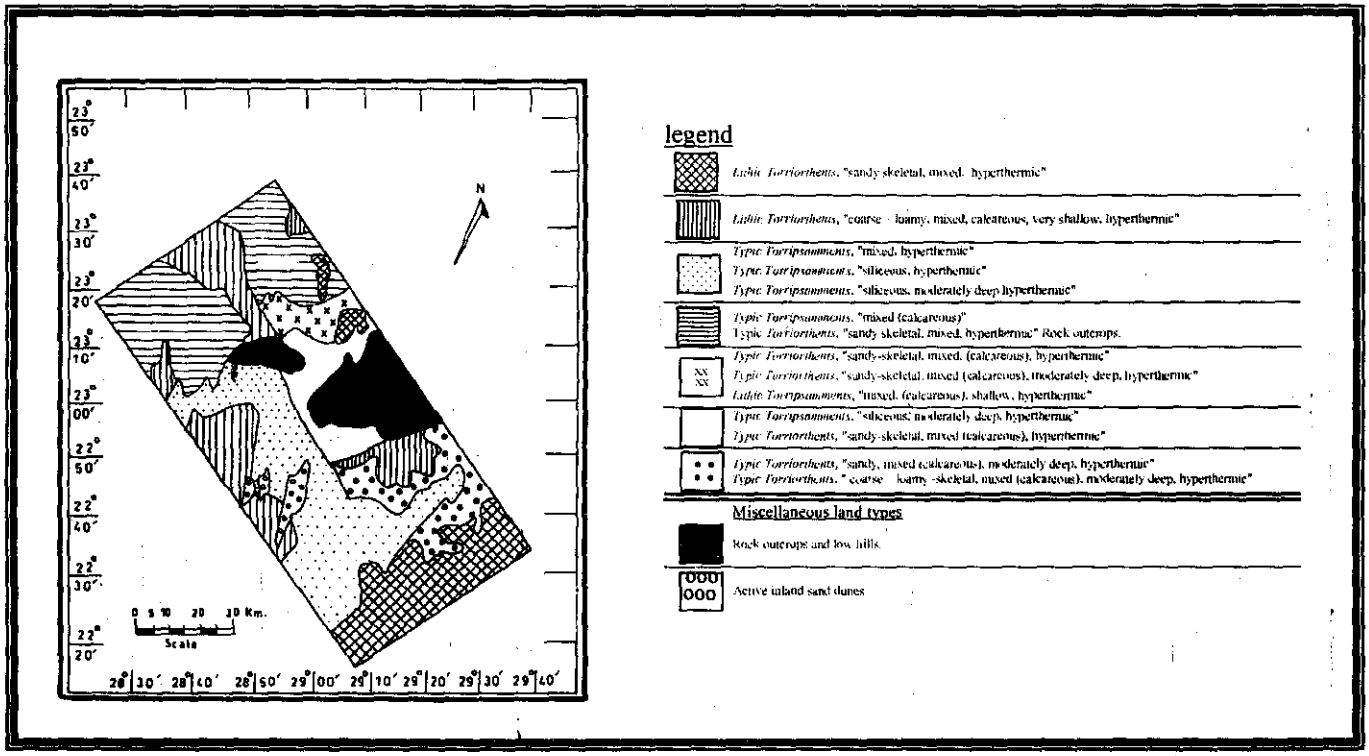

Fig. 4. Soil association map of El-Tarfawi-Debis extension area.

TABLE 2. Some morphological characteristics of the studied pedons.

Physiogr. unit	Pedon No.	Depth. cm	Color		Texture	Structure	Consistence			Boundary	other features
			Dry	moist			Dry	wet (st)	wet (pl)		
Almost flat Sand terrain	5	0-12	10YR 7/4	10YR 6/4	GS	SG	LO	NST	NPL	CS	
		12-23	10YR 7/6	10YR 6/6	GS	M	SHA	SST	NPL	AS	
	7	0-31	10YR 8/4	10YR 7/4	S	SG	LO	NST	NPL	DS	
		31-90	10YR 7/4	10YR 6/4	S	SG	LO	NST	NPL	AS	
	8	0-25	10YR 7/4	10YR 6/4	SGS	SG	LO	NST	NPL	CS	
		25-76	7.5YR 7/4	7.5YR 5/4	GS	M	HA	NST	NPL	AS	
	10	0-33	7.5YR 7/4	7.5YR 5/4	GLS	M	HA	NST	NPL	GS	
		33-87	7.5YR 7/4	7.5YR 5/4	VGLS	M	HA	SST	NPL	CS	fine lime segregations
		87-150	7.5YR 6/4	7.5YR 5/4	VGLS	M	VHA	SST	NPL	AS	fine lime segregations
	12	0-20	10YR 7/6	10YR 6/6	VGLS	M	SHA	ST	PL	AS	
		26-64	7.5YR 7/4	7.5YR 5/4	GSL	M	HA	ST	PL	CS	
		64-85	7.5YR 7/4	7.5YR 5/4	GLS	M	EHA	SST	NPL	GS	lime occurs as powder
	15	0-17	10YR 7/6	10YR 6/6	GS	SG	SO	NST	NPL	AS	
		17-77	7.5YR 4/4	7.5YR 3/4	VGS	M	VHA	NST	NPL	AS	fine and medium lime nodules
	16	0-22	7.5YR 7/6	7.5YR 6/6	GS	M	HA	NST	NPL	GS	
		22-56	7.5YR 7/4	7.5YR 5/4	GS	M	HA	NST	NPL	CS	many lime nodules
		56-120	7.5YR 7/4	7.5YR 6/4	GS	M	VHA	NST	NPL	CS	many fine lime segregations
	17	0-22	10YR 7/4	10YR 6/4	SGS	SG	LO	NST	NPL	CS	
		22-48	7.5YR 7/6	7.5YR 6/6	SGS	M	HA	NST	NPL	AS	few fine lime spots
	19	0-40	10YR 8/3	10YR 7/3	GS	SG	HA	NST	NPL	DS	Common gypsum spots
		40-93	7.5YR 4/4	7.5YR 3/4	GS	SG	SO	NST	NPL	CS	many gypsum spots
		93-140	7.5YR 4/4	7.5YR 3/4	GS	M	HA	NST	NPL	AS	few fine lime segregations
	20	0-35	10YR 7/4	10YR 6/4	SGS	SG	SO	NST	NPL	DS	
		35-90	10YR 7/4	10YR 6/4	GS	SG	SO	NST	NPL	DS	
		90-110	10YR 7/4	10YR 6/4	GS	M	HA	NST	NPL	AS	

TABLE 2. Contd.

Physiogr. Unit	Pedon No.	Depth, cm	Colour		Texture	Structure	Consistence			Boundary	other features
			Dry	Moist			Dry	wet (sl)	wet (pl)		
	21	0-25	10YR 7/4	10YR 6/4	GS	SG	LO	NST	NPL	AS	
	24	0-30	10YR 7/4	10YR 6/4	GLS	SG	SO	SST	NPL	AS	
		30-75	7.5YR 7/4	7.5YR 6/4	VGS	M	SHA	NST	NPL	GS	
		75-125	7.5YR 7/4	7.5YR 5/4	VGS	M	HA	NST	NPL	AS	
	25	0-30	7.5YR 7/6	N.D.	G	---	---	---	---	DS	
		30-47	7.5YR 7/6	N.D.	G	---	---	---	---	CS	
		47-68	7.5YR 7/4	7.5YR 5/4	VGLS	M	HA	---	---	CS	few lime nodules
Almost flat Deflated terrain	1	0-18	10YR 7/4	10YR 6/4	SGS	M	SHA	NST	NPL	CS	
		18-75	7.5YR 7/6	7.5YR 6/6	S	M	HA	NST	NPL	CS	
		75-150	7.5YR 7/6	7.5YR 6/6	S	M	EHA	NST	NPL	AS	
	2	0-25	7.5YR 7/6	7.5YR 6/6	SGS	M	SHA	NST	NPL	CS	
		25-57	7.5YR 8/4	7.5YR 7/4	GS	M	SHA	NST	NPL	DS	
		57-85	7.5YR 8/4	7.5YR 7/4	GS	M	SHA	SST	NPL	AS	
	3	0-23	10YR 8/3	10YR 7/3	GS	SG	LO	NST	NPL	CS	
		23-57	10YR 7/4	10YR 6/4	GS	SG	LO	NST	NPL	CS	
		57-85	10YR 7/4	10YR 6/4	GS	M	HA	NST	NPL	AS	
	6	0-51	7.5YR 8/4	7.5YR 7/4	GLS	M	SHA	SST	NPL	DS	
		51-110	7.5YR 8/4	7.5YR 7/4	GLS	M	HA	SST	NPL	AS	
		110-140	7.5YR 7/6	7.5YR 6/6	VGLS	M	EHA	NST	NPL	GS	
	11	0-35	10YR 7/4	10YR 6/4	S	SG	LO	NST	NPL	DS	
		35-86	10YR 7/4	10YR 6/4	S	SG	SO	NST	NPL	DS	
		86-140	10YR 8/3	10YR 7/3	S	SG	SO	NST	NPL	AS	
Undulating sand terrain	13	0-13	7.5YR 7/6	7.5YR 6/6	VSGS	SG	LO	NST	NPL	AS	
	22	0-23	7.5YR 8/4	7.5YR 7/4	GS	SG	LO	NST	NPL	AS	
Strongly weathered rock-land	4	0-10	10YR 7/4	10YR 6/4	GS	SG	LO	NST	NPL	AS	
	9	0-10	7.5YR 7/6	7.5YR 7/6	GLS	SG	SO	SST	NPL	AS	few fine lime spots
		10-25	7.5YR 7/6	7.5YR 7/6	GLS	M	SHA	SST	NPL	AS	few fine lime spots
	14	0-15	7.5YR 8/4	7.5YR 7/4	GLS	M	HA	SST	NPL	CS	
		15-50	7.5YR 7/6	7.5YR 6/6	VGLS	M	VHA	NST	NPL	CS	
	18	0-10	10YR 8/3	10YR 7/3	GS	M	SHA	NST	NPL	AS	
		10-47	7.5YR 6/6	7.5YR 6/6	GLS	M	VHA	NST	NPL	GS	
	23	0-22	10YR 8/3	10YR 7/3	GSL	SG	SO	ST	PL	CS	
		22-47	7.5YR 7/6	7.5YR 6/6	SGLS	M	HA	ST	SPL	AS	

S	*Sand*	M	*Massive*	NST	*Non Sticky*	AS
LS	*Loamy sand*	SG	*Single grain*	SST	*Slightly Sticky*	CS
SL	*Sandy Loam*			ST	*Sticky*	GS
G	*Gravely*	LO	*Loose*	NPL	*Non Plastic*	DS
VG	*Very Gravely*	So	*Soft*	SPL	*Slightly Plastic*	
GS	*Gravely Sand*	SHA	*Slightly Hard*	PL	*Plastic*	
		HA	*Hard*			
		VHA	*Very Hard*			

TABLE 3. Some physical and chemical properties of the studied pedons.

Physiographic unit	Pedon No.	Depth cm	Gravel %	Particle size (mm) distribution (%)							Textural class	SP %	$CaCO_3$ %	EC dS/m	pH Paste
				VCS 2-1	CS 1-0.5	MS 0.5-0.25	FS 0.25-0.125	VFS 0.125-0.05	Silt 0.05-0.02	Clay < 0.002					
Almost flat Sand terrain	5	0-12	15.80	20.11	17.71	23.99	31.11	7.08	---	---	GS	17.11	3.16	0.10	7.9
		12-23	34.70	11.13	15.50	8.99	21.86	23.34	15.34	3.87	GS	23.63	3.40	1.03	8.1
	7	0-31	---	4.50	16.60	33.72	28.11	10.73	6.34		S	19.20	2.11	0.58	8.5
		31-90	---	3.50	22.11	28.18	26.18	15.76	4.27		S	19.92	2.97	0.34	8.7
	8	0-25	5.01	2.22	13.97	36.60	24.87	18.99	3.35		SGS	23.50	2.21	0.76	7.2
		25-76	7.65	6.43	16.41	30.18	26.12	16.59	4.27		GS	20.92	2.03	3.11	7.2
	10	0-33	25.53	11.53	15.25	27.91	16.11	5.57	15.72	7.91	GLS	23.24	3.24	0.29	8.1
		33-87	50.11	11.92	13.50	25.99	23.36	6.11	11.11	8.01	VGLS	19.81	22.25	0.53	7.9
		87-150	55.02	10.32	15.96	28.12	20.18	5.01	10.70	8.83	VGLS	30.31	24.04	0.58	8.0
	12	0-20	45.02	11.16	8.13	20.11	13.11	10.13	22.11	15.25	VGLS	25.26	5.63	1.11	7.9
		26-64	28.86	3.50	8.31	21.11	9.13	12.66	28.17	17.12	GSL	24.11	6.02	2.47	7.9
		64-85	33.56	11.01	13.11	21.97	7.89	30.46	7.45	8.11	GLS	21.33	11.37	5.01	7.9
	15	0-17	45.76	16.73	13.11	30.87	24.00	12.73	2.56		GS	16.98	4.11	0.47	7.4
		17-77	69.94	4.14	7.74	26.31	40.83	17.91	3.07		VGS	17.82	17.71	17.71	7.4
	16	0-22	27.00	12.23	16.96	35.00	25.03	4.58	6.23		GS	22.24	22.01	0.71	7.7
		22-56	28.45	11.60	15.42	34.84	26.11	6.49	5.54		GS	25.16	55.57	3.14	7.7
		56-120	35.55	11.01	14.12	27.87	15.18	28.64	3.18		GS	19.91	41.21	3.00	7.9
	17	0-22	4.21	3.11	12.81	31.32	26.18	22.45	4.13		SGS	15.70	6.31	0.28	7.7
		22-48	5.25	6.72	15.01	29.18	29.65	17.47	1.97		SGS	16.82	11.14	0.29	7.9
	19	0-40	9.91	21.35	18.42	30.76	9.00	14.36	6.11		GS	18.90	6.52	0.28	7.5
		40-93	15.33	20.02	19.00	24.17	24.10	6.76	5.89		GS	20.13	6.99	0.19	7.5
		93-140	14.00	21.75	16.80	24.61	23.00	7.00	7.74		GS	19.91	11.03	0.21	7.6
	20	0-35	5.03	4.16	11.77	29.91	27.16	21.22	5.78		SGS	20.21	3.11	0.28	7.7
		35-90	10.52	8.14	10.04	37.75	30.12	11.84	2.11		GS	19.82	3.42	0.27	7.7
		90-110	13.44	6.34	9.18	27.16	25.87	29.87	1.58		GS	19.77	10.10	0.21	7.7
	21	0-25	28.00	4.11	10.18	35.16	30.94	14.50	5.11		GS	22.11	1.52	0.21	7.4

TABLE 3. Contd.

Physiographic Unit	Pedon No.	Depth cm	Gravel %	Particle size (mm) distribution (%)							Textural class	SP %	$CaCO_3$ %	EC dS/m	pH Paste
				VCS 2-1	CS 1-0.5	MS 0.5-0.25	FS 0.25-0.125	VFS 0.125-0.05	Silt 0.05-0.02	Clay < 0.002					
	24	0-30	27.24	9.91	13.55	28.01	28.00	2.71	12.11	5.72	GLS	21.46	2.91	0.52	7.9
		30-75	50.73	11.00	8.73	29.18	30.42	19.11	1.56		VGS	23.24	4.23	0.68	7.9
		75-125	67.01	3.01	7.96	22.17	40.31	24.36	2.19		VGS	20.72	4.01	0.50	7.9
	25	0-30	97.15	---	---	---	---	---	---		G	N.D.	N.D.	N.D.	N.D.
		30-47	95.76	---	---	---	---	---	---		G	N.D.	N.D.	N.D.	N.D.
		47-88	66.51	21.74	16.15	18.52	8.12	16.23	11.60	7.64	VGLS	23.12	17.87	3.66	7.4
Almost flat Deflated Terrain	1	0-18	4.47	4.15	16.66	32.11	29.13	17.50	0.45		SGS	15.17	1.11	0.21	7.6
		18-75	---	2.51	17.18	31.52	29.00	17.56	2.23		S	18.32	0.92	0.20	7.4
		75-150	---	3.35	22.03	32.00	28.99	11.66	1.97		S	20.11	0.90	0.19	7.3
	2	0-25	5.23	7.11	16.18	30.00	13.12	29.17	4.42		SGS	21.51	3.06	0.28	8.0
		25-57	9.01	9.62	10.12	31.11	14.17	33.42	1.56		GS	20.44	3.96	0.31	7.9
		57-85	10.10	11.17	21.19	19.71	11.12	18.69	6.12	12.00	GS	23.86	7.01	0.64	8.0
	3	0-23	12.71	13.44	13.12	35.97	26.42	10.51	0.54		GS	22.11	1.51	0.09	7.7
		23-57	30.72	18.16	11.02	28.33	22.16	18.61	1.72		GS	23.71	0.44	0.23	7.6
		57-85	32.84	23.18	16.87	21.86	24.12	11.70	2.27		GS	23.00	1.23	0.25	7.6
	6	0-51	24.00	10.11	10.17	23.81	18.01	21.44	7.65	8.81	GLS	21.00	4.46	0.50	7.8
		51-110	29.97	3.01	6.11	27.13	24.62	23.58	5.12	10.43	GLS	22.23	2.01	1.57	7.5
		110-140	38.87	17.13	15.71	19.00	16.87	14.30	7.52	9.97	VGLS	20.41	1.98	1.98	7.7
	11	0-35	1.00	10.11	10.82	16.22	26.40	30.34	6.11		S	24.24	3.11	0.20	7.6
		35-86	1.42	9.13	6.74	22.01	33.45	22.83	5.84		S	18.81	3.85	0.20	7.8
		86-140	1.24	10.01	7.16	21.97	32.25	20.87	7.74		S	19.74	3.62	0.18	7.5

TABLE 3. Contd.

Physiographic unit	Pedon No.	Depth cm	Gravel %	Particle size (mm) distribution (%)							Textural class	SP %	$CaCO_3$ %	EC dS/m	pH Paste
				VCS 2-1	CS 1-0.5	MS 0.5-0.25	FS 0.25-0.125	VFS 0.125-0.05	Silt 0.05-0.02	Clay < 0.002					
Undulating sand terrain	13	0-13	2.10	7.49	18.19	32.41	27.00	10.65	4.26		VSGS	19.87	4.86	0.23	7.7
	22	0-23	31.50	17.62	11.11	26.69	21.02	22.03	1.53		GS	23.16	9.71	0.32	8.0
Strongly weathered rock-land	4	0-10	25.40	11.48	19.23	30.11	26.61	12.06	0.51		GS	19.31	3.42	0.10	8.0
		10-23	55.70	14.12	13.11	29.99	12.87	28.80	1.11		VGS	19.98	27.80	0.15	8.1
	9	0-10	23.40	3.56	7.14	14.91	10.11	38.83	18.79	6.72	GLS	21.91	10.16	0.26	7.5
		10-25	31.60	2.71	6.17	27.02	26.18	18.97	3.11	5.84	GLS	22.18	10.34	0.25	7.4
	14	0-15	42.25	11.76	10.46	18.81	7.01	32.09	11.13	8.74	GLS	20.00	2.01	0.53	7.4
		15-50	58.10	13.92	11.13	30.70	12.81	11.12	12.60	7.72	VGLS	21.76	2.31	2.77	7.5
	18	0-10	34.17	17.26	15.14	23.15	22.00	16.89	5.65		GS	17.62	2.79	0.20	7.5
		10-47	38.01	15.52	12.60	23.11	18.17	13.65	10.31	6.64	GLS	24.45	5.82	0.32	7.7
	23	0-22	13.61	4.12	9.11	21.75	13.69	15.08	21.11	15.14	GSL	29.31	5.12	0.27	8.7
		22-47	7.14	5.11	18.16	27.13	17.16	15.22	17.22	18.00	SGLS	31.45	7.03	0.89	8.3

Soils of the "almost flat sand terrain"

This landscape unit characterizes most of the northern part of the area and extends southward as well, forming narrow belt between the "rock exposure" unit in the east and "Almost Flat Deflated Plain" in the west. This particular unit might be interrupted by "rock exposures" or "low isolated hills" (Plate 4a ,4b).

This land unit involves a wide range of soil types as soil depth, gravel content, and mineralogical class are considered. Land surface is almost flat to slightly undulating. The majority of this unit, dominated by both deep and moderately deep soils, are represented by profiles 7, 8, 10, 12, 15, 16, 20, 24 and 25. Other soils, but the least common, are shallow and very shallow are represented by profiles 5, 17 and 21.

Soil colour varies between very pale brown (10YR 7/4) and reddish yellow (7.5YR 7/6) in surface layers and between reddish yellow (7.5YR 7/6) tp dark brown (7.5YR 4/4) in subsoil. Soil texture is generally sandy except for soils represented by profiles 12 and 25 which have sandy loam subsoil. Gravel content is relatively high getting around 50%, 69%, and 97.5% in profiles 24, 15 and 25, respectively. Even though, in some few cases gravel content is rather low or even absent. Carbonate content varies between 1.52% and 55.5% in profiles 2 and 16, respectively. Carbonates present in different forms, i.e. segregation , nodules, spots or powdery in profiles 10, 16, 17, 19, and 20. Soil salinity is rather low as EC values range from 0.1 to 3.1 dS/m. In few cases it reaches 17.7 dS/m as in case of profile 15.

The following is an account of the taxa units identified:

- *Deep soils (with > 35% gravel content),* represented by profiles 10 and 16 and others with < 35% gravel content could be classified into:
  1. Mixed (calcareous), hyperthermic, *Typic torripsamments* (Profiles 19 and 20).
  2. sandy-skeletal, mixed (calcareous), hyperthermic *Typic torriorthents* (Profiles 10 and 16).
- *Moderately deep soils,* represented by profiles 7 and 8 have sandy texture with less than 35%, gravel content throughout the whole profile depth. So that, they are placed to the family; siliceous, moderately deep, hyperthermic, *Typic torripsamments.*
- *Other moderately deep soils,* represented by profiles 12, 15, and 25 acquiring > 35% gravel content, can be classified as:
  1. "coarse loamy, mixed (calcareous), moderately deep, hyperthermic", *Typic torriorthents* (Profile 12).
  2. "sandy-skeletal, mixed (calcareous)", moderately deep, hyperthermic *Typic torriorthents* (Profiles 15 and 25).
- *Shallow sandy soils,* represented by profile 17 which belongs to the family; mixed, hyperthermic, *Lithic torripsamments.*

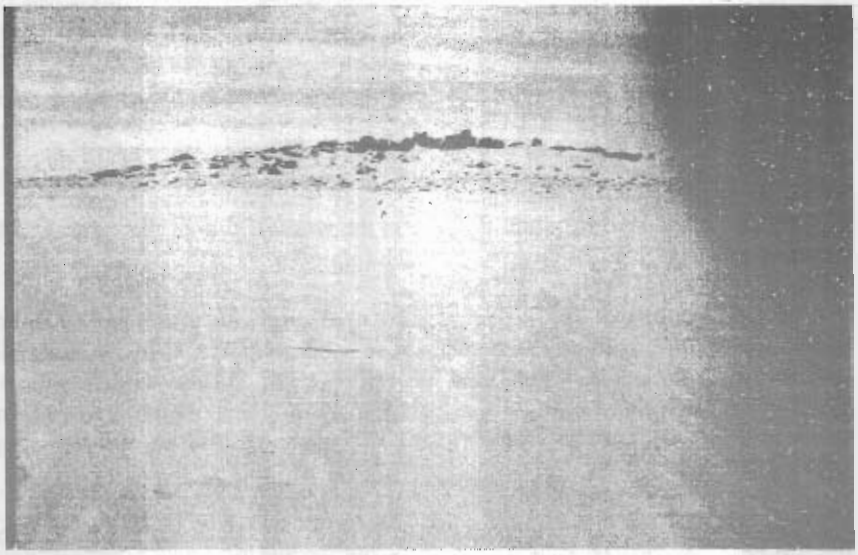

Plate 4a. Almost flat sand terrain.

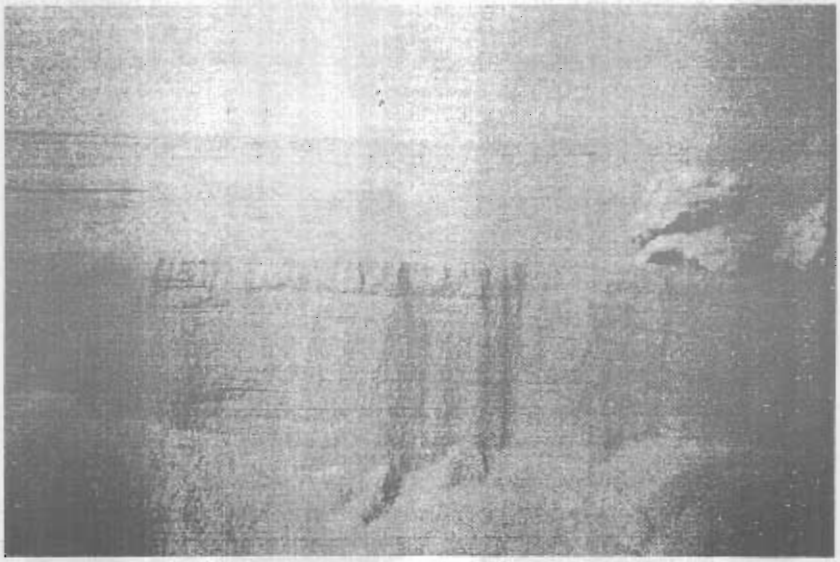

Plate 4b. Deep sandy soils formed on sand terrain.

- *Very shallow sandy soils* are qualified to soil families; namely:
  1. "sandy, mixed (calcareous), hyperthermic", *lithic torriorthents*.
  2. "sandy-skeletal, mixed (calcareous)", hyperthermic *Lithic torriorthents* (Profiles 5).

Soils of the almost flat "deflated plain"

This particular landform unit dominates the western side of the central part of the study area and extends farther due south (plate 5).

The majority of this unit is occupied by moderately deep to deep sandy soils with varied gravel content ranging between 1.00 and 38.87% by volume. Soil colour varies between very pale brown (profiles 3 and 11) and reddish yellow or pink for the subsurface layers of the profiles 1, 2 and 6. Soils are generally non saline as EC values range from 0.09 to 1.57 dS/m. Carbonate content ranges between 0.44 and 7.01%.

Accordingly, *Typic torripsamments* clearly dominates this landscape unit. Nevertheless, *Typic torriorthents* exists but to a lesser extent. At soil family level, soils could be distinguished into the following:

- "siliceous, hyperthermic", *Typic torripsamments* (profile 3).
  mixed (calcareous), hyperthermic, *Typic torripsamments* (profile 11).

- sandy-skeletal, mixed (calcareous), hyperthermic, *Typic torriorthents* (profile 6).

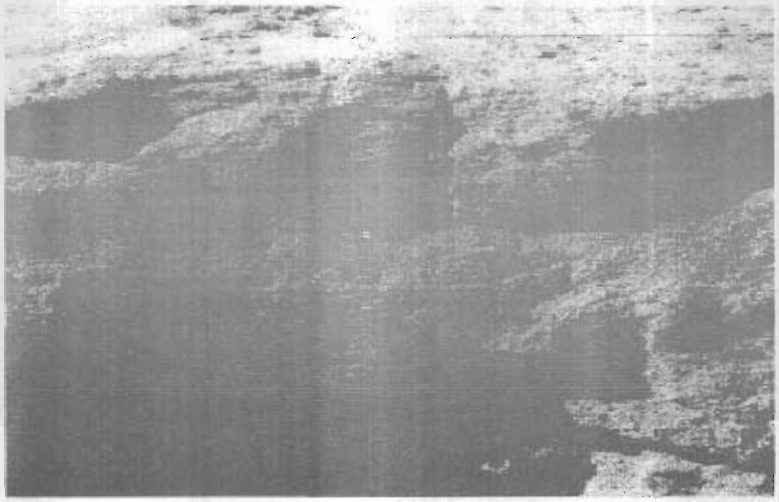

Plate 5. Gravelly sand soils with reddish yellow characterizing the flat deflated plain.

Soils of both undulating "sand terrain" and "deflated plain"

This units occupy a rather less extended small patches within the extreme northern part of the "almost flat sand terrain" (plate 6) . The soils are very shallow, gravelly to slightly gravelly sand as gravel content ranges between 2.10 and 31.00%. Soils are calcareous (as lime content ranges from 4.8 to 9.7%) and non saline (as EC values range from 0.23 and 0.32 dS/m). One soil family could identified, which is; sandy, mixed (calcareous), hyperthermic", *Lithic torriorthents*.

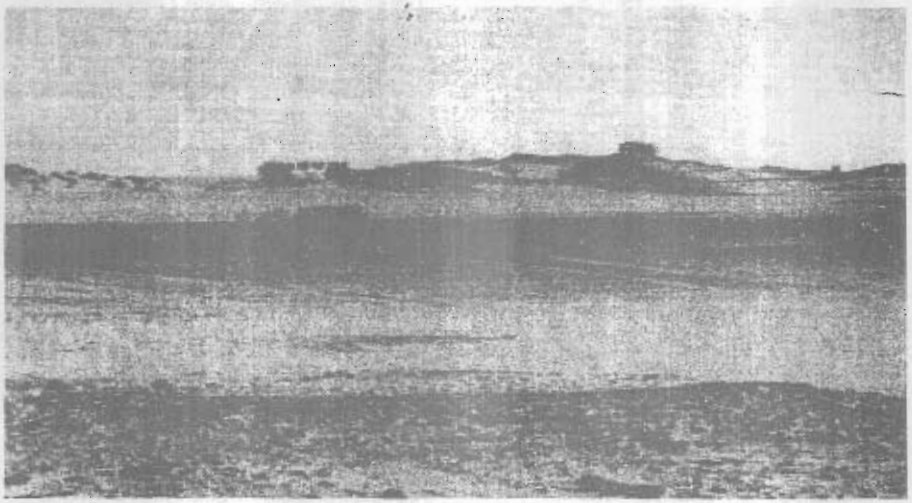

Plate 6. Gently undulating deflated plain with desert pavement and isolated hills as remnants of old surface.

Soils of the "strongly weathered rock land"

This unit is the most noticeable in both the extreme southern part and the middle of the eastern part of the study area. It is characterized by the occurrence of shallow and very shallow sandy and/or gravelly sand soils; (plate 7). Their representative profiles are 4, 9, 14, 18, and 23. Soils are slightly calcareous to calcareous as the total carbonate content ranges from 2.01 to 10.00%. Soils are non saline as EC values are between 0.1 and 2.77 dS/m. Two soil families, namely; coarse loamy, mixed (calcareous), hyperthermic, *Lithic torriorthents* (profiles 9 and 23)and sandy-skeletal, mixed (calcareous), hyperthermic, *Lithic torriorthents* (profiles 4, 14 and 18)could be distinguished.

Land evaluation

Land evaluation could be carried out on bases of three different parametric systems, namely, Modified Storie Index (Nelson, 1963) and land suitability for irrigated agriculture (Sys & Verhèy, 1978) and a parametric land evaluation system *(PLES-arid model)* suggested by Khalifa (2004).

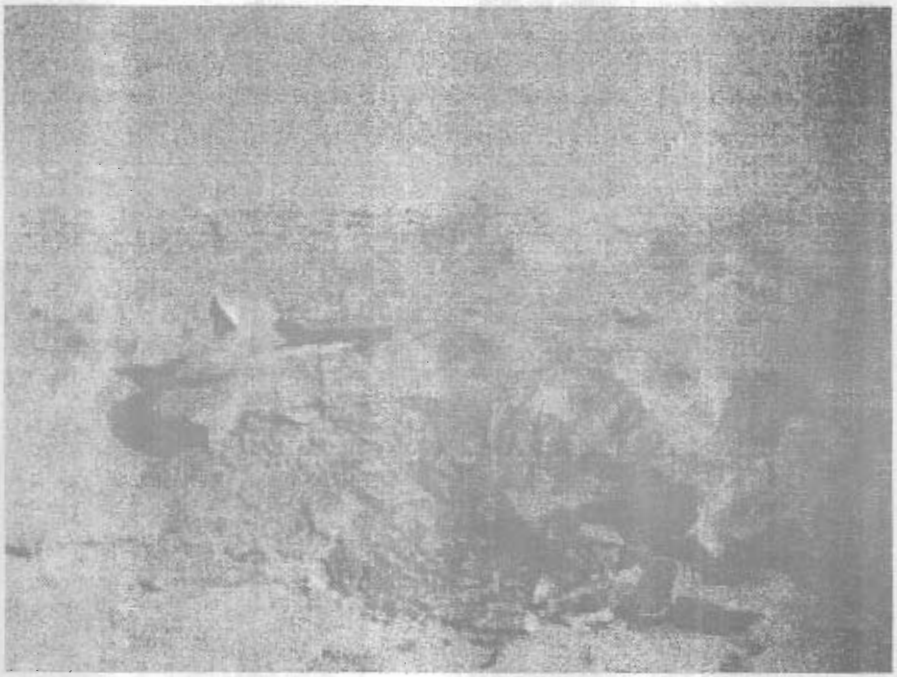

Plate 7. Very shallow sandy soils formed on depressions of gently undulating terrains.

Modified storie index (Nelson , 1963)

Data in Table 4 indicate that, soil under consideration fall into two land classes which are D and E. The former corresponds to "currently unsuitable". It has suitability index ranging from 30.4 – 47% of soil profiles number 17 and 15, respectively. To this class a wide range of soils differing in depth and gravel content, belong. Within the group some soils represented by profiles 7, 14, 17, 18 and 28 fall within the transitional zone between E and D class, as the index of land productivity is in the range between 30.4 and 33.0%. Concerning land categorized as E, it is represented by profiles 4, 5, 9, 13, 21 and 22. The productivity index of which varying from 11.5 (profile 4) to 15.0 (profile 9).

Accordingly, the land at the best is considered currently unsuitable for agriculture activity. It is worthy to state that, with respect to the system of land evaluation applied, the index could not determine the differences among the wide range of families belonging to the class (D). Even though class (E) was formed restricted to only very shallow and shallow soils.

TABLE 4. Land productivity class according to modified storie index (Nelson , 1963) .

Prof. No.	Character (A)	Surface texture (B)	Slope (C)	Land elements (x)			Productivity Index	Land class
				Erosion (X_1)	pH (X_2)	Fertility (X_3)		
1	98	75	100	84	100	75	46.0	D
2	98	75	95	84	85	75	39.0	D
3	95	75	100	84	87	75	39.0	D
4	40	75	95	84	87	75	11.5	E
5	40	65	95	84	85	75	13.3	E
6	100	85	100	84	85	75	46.0	D
7	95	65	100	84	85	75	33.0	D → E
8	95	75	95	84	98	75	42.0	D
9	40	75	100	84	100	75	19.0	E
10	100	75	100	84	85	75	40.0	D
11	100	75	100	84	100	75	47.0	D
12	93	90	100	84	85	75	45.0	D
13	40	75	100	84	100	75	19.0	E
14	60	85	100	84	98	75	32.0	D → E
15	95	75	95	84	98	75	42.0	D
16	93	75	100	84	100	75	44.0	D
17	65	90	100	84	87	75	30.4	D → C
18	65	75	100	84	100	75	31.0	D → E
19	100	75	100	84	100	75	47.0	D
20	100	75	95	84	86	75	39.0	D
21	40	75	100	84	99	75	19.0	E
22	40	75	100	84	85	75	16.0	E
23	60	95	100	84	85	75	31.0	D → C
24	97	85	100	84	85	75	44.0	D
25	95	65	100	84	98	75	38.0	D

Land suitability for irrigated agriculture (Sys & Verhèy, 1978)

Data in Table 5 revel that, soils could be distinguished in terms of the suitability index into three class, *i.e.*, (S_3), (N_1) and (N_2). (S_3) class has suitability index differing from 28.7 to 36.9% of profiles 10 and 23, respectively. This class could not be identified when applying Storie Index. (S_3) dominates the moderately deep, medium textured and deep gravelly, sandy soils, that are represented by profiles 6, 10, 12, 16 and 23.

TABLE 5. Land suitability class for irrigated agriculture (Sys & Verhèy, 1978).

Profile No.	Topography (t)	Water table (W)	Soil characteristics (S)				Salinity (n)	Soil Index	Land class
			Texture (S_1)	Depth (S_2)	Total carbonate (S_3)	Gypsum (S_4)			
1	100	95	30	100	95	90	96	2304	N_1
2	90	95	30	100	95	90	96	21.0	N_1
3	100	80	60	75	95	90	96	12.3	N_1
4	90	65	25	55	100	90	96	7.0	N_2
5	90	65	35	55	95	90	96	9.2	N_2
6	100	95	45	100	95	90	96	35.0	S_3
7	100	90	30	90	95	90	96	19.9	N_1
8	100	65	45	55	95	90	96	13.2	N_1
9	100	65	45	55	95	90	96	9.2	N_2
10	100	95	35	100	100	90	96	28.7	S_3
11	90	95	30	100	95	90	96	21.0	N_1
12	100	80	60	75	95	90	96	29.6	S_3
13	100	60	30	30	95	90	96	4.4	N_2
14	100	65	25	55	95	90	96	7.3	N_2
15	100	80	25	75	100	90	96	11.7	N_2
16	100	90	25	90	95	90	96	35.0	S_3
17	90	65	30	55	95	90	96	7.9	N_2
18	100	80	25	55	95	90	96	9.0	N_2
19	100	95	30	100	95	90	96	23.4	$S_3 \rightarrow N_2$
20	90	95	30	100	95	90	96	21.4	$S_3 \rightarrow N_2$
21	100	65	25	55	95	90	96	7.3	N_2
22	100	65	25	30	95	90	96	4.0	N_2
23	100	80	75	75	95	90	96	36.9	S_3
24	100	90	35	90	95	90	96	23.3	$S_3 \rightarrow N_2$
25	90	90	25	90	100	90	96	17.5	N_1

Soil families related to (S_3) are coarse- loamy, mixed (calcareous) moderately deep, hyperthermic *Typic torrioxthents* and Sandy- skeletal, mixed (calcareous) hyperthermic *Typic torriorthents*.

Soils belonging to class (N_1) "currently not suitable" which are represented by profiles 1, 2, 3, 7, 8, 11, 19, 20 and 24, have suitability index fluctuates between 12.3 and 23.4% of profiles 3 and 4, respectively. This classes involves a wide spectrum of soil families belonging to *Typic torripsamments*, which are, Sandy – skeletal, mixed (calcareous), hyperthermic *Typic torriorthents;* Siliceous, hyperthermic *Typic torripsamments* and mixed (calcareous), hyperthermic *Typic torripsamments*.

Nevertheless, clear distinction between deep and moderately deep soil could not be realize in many cases.

Considering the permanently unsuitable land (N_2), represented by profiles 4, 5, 9, 13, 14, 17, 18, 21 and 24, has suitability index ranging between 4 and 11.7%. It includes shallow and very shallow soils classified as; *Lithic torriothents* or *Torripsamments*.

*Parametric land evaluation "PLES-arid mode"l(Khalifa,*2004)

Data in Table 6 shows that the land of the studied area belongs to two classes; namely; (C_3) "Fair" and (C_4) "Poor" lands. The fair land (C_3) almost dominates the deep and moderately deep sandy soils with index from 46.10 to 50.69%. It is represented by profiles 6, 10, 12 and 23. While the poor land has which index between 32.32 and 38.33% occupies a limited area with moderately deep gravelly sand and very shallow soils. It is represented by profiles 3, 8, 25 .

TABLE 6. Land productivity of the studied area using PLES-arid model (Khalifa, 2004).

Prof. No.	productivity index (%)	Soil class	Prof. No.	productivity index (%)	Soil class
1	35.34	C4 (Poor)	14	45.57	C3 (Fair)
2	42.59	C3 (Fair)	15	37.91	C4 (Poor)
3	36.99	C4 (Poor)	16	34.95	C4 (Poor)
4	33.41	C4 (Poor)	17	36.61	C4 (Poor)
5	35.33	C4 (Poor)	18	40.54	C3 (Fair)
6	49.33	C3 (Fair)	19	43.53	C3 (Fair)
7	42.29	C3 (Fair)	20	40.14	C3 (Fair)
8	38.33	C4 (Poor)	21	36.75	C4 (Poor)
9	37.80	C4 (Poor)	22	32.32	C4 (Poor)
10	50.69	C3 (Fair)	23	46.10	C3 (Fair)
11	44.72	C3 (Fair)	24	43.81	C3 (Fair)
12	46.71	C3 (Fair)	25	39.41	C4 (Poor)
13	33.91	C4 (Poor)			

Where,

Productivity index	Land class
80-100	Very good
60-80	Good
40-60	Fair
20-40	Poor
0 – 20	Very Poor

From Table 7 one could be conclude that, the modified Storie Index of land productivity evidenced that, lands of class (E) is confined to all soil families belonging to the lithic subgroup of both *Torriorthents* and *Torripsamments*. Besides, soils with different particle size class, of the control section, are included within the same land class, that can be rendered to the fact that this system gives weight to the texture of the surface layer only.

With regard to the productivity Index suggested by Khalifa, (2004), different families of the subgroup *Typic torripsamments* belong to the C_3 class. On the other hand, soil related to the subgroup *Typic torripsamments*. sandy –skeletal in particular, has productivity rating C_3 that is close to C_4. Exceptional being, soils with coarse -loamy particle size are categorized as C_3. Shallow and very shallow soils almost being to the same class C_4.

With respect to the system outlined by Sys & Verhèy (1978), shallow and very shallow soils show suitability class are in harmony with that provided by the other tow approaches. With respect to Typic subgroup of *Torriorthents.* and *Torripsamments.*, this approach could not distinguish between soils with different depth and / or particle size class.

The previous discussion clearly indicates that, the productivity Index that reported by Khalifa, (2004) may take the presidency of the other two approaches in the differentiation among the studied soils.

Land suitability for crops according to PLES- Arid Model (Khalifa. 2004)

The studied soils Table 8 show that, the moderate suitability for wheat, barley, where suitability index fall within the rang 60 to 80% . Nevertheless, in some soils, represented by profiles 10, 12, 14 and 23 have high suitability indices for both of wheat (of 88.16, 83.29, 84.62 and 85, respectively) and barely (85.88, 83.29, 84.62 and 85.85.88 respectively).

As for maize and potatoes, the test showed that, the indices are in the range 40 to 60% indicating marginal suitability. While the suitability for tomatoes is moderate with index differing from 50.10 to 62.41%. But the land shows moderate to high suitability for onion and alfalfa as indicated from the indices which vary from 69.66 to 89.11% and 52.40 to 94.90% for onion alfalfa, respectively.

For fruit tree, the majority of the land showed non – suitability for tested trees except for pear to which only deep soils display moderate suitability.

From the aforementioned discussion, it is clear that the land productivity, at the best, is marginal and that is referred to the nature of the soil parent materials with low fertility, limited root zone, and rarity of precipitation.

Also, land suitability for crops is moderate to high for a limited number of crops, *i.e.* wheat, barley, onion and alfalfa.

TABLE 7 . Land classification in relation to soil taxa in El – Torfawi – Debis extension area, south valley region .

Taxonomic unit	Modified Storie Index	Productivity Index PLES-arid	Suitability for irrigation Index
Mixed (calcareous), hyperthermic typic Torripsamments	D	C_3	$N_1 \longrightarrow S_3$
Siliceous, hyperthermic TypicTorripsamments	D	C_3	$N_1 \longrightarrow S_3$
Siliceous, moderately deep hyperthermic Typic torripsamments	D	C_3	N_1
Sandy – skeletal, mixed (calcareous), hyperthermic Typic Torriorthents	D	$C_3 \longrightarrow C_4$	S_3
Sandy – skeletal, mixed (calcareous), moderately deep ,hyperthermic Typic Torriorthents	D	$C_3 \longrightarrow C_4$	$N_1 \longrightarrow N_2$
Coarse – loamy moderately deep, hyperthermic Typic Torriorthents	D	C_3	S_3
Sandy – skeletal, mixed (calcareous,)very shallow hyperthermic Lithic Torriorthents	E	C_4	N_2
Sandy, mixed (calcareous), hyperthermic, Lithic Torriorthents	E	C_4	N_2
Coarse – loamy, mixed (calcareous), hyperthermic, Lithic Torriorthents	D	$C_3 \longrightarrow C_4$	$N_3 \longrightarrow S_3$
Mixed (calcareous), hyperthermic, Lithic Torripsamments	D $\longrightarrow$ E	C_4	N_2

TABLE 8. Land suitability indices for some crops, using PLES - Arid model (Khalifa, 2004).

Profile No.	Wheat	Barley	Maize	Alfalfa	Onion	Potatoes	Tomatoes	Pear
1	67.07	67.07	47.05	74.19	69.66	51.43	50.10	67.07
2	78.09	78.09	54.73	86.31	81.04	58.29	58.29	73.32
3	69.46	69.46	48.70	76.80	81.42	53.24	51.87	69.17
4	69.06	67.28	44.28	71.68	69.83	46.66	50.23	0.00
5	71.49	71.49	47.05	74.19	74.19	51.44	53.67	0.00
6	85.88	85.88	60.18	94.90	86.81	65.79	64.09	83.66
7	78.46	78.46	54.99	86.72	81.42	60.12	58.56	69.17
8	72.94	72.94	49.81	78.55	73.75	54.45	54.45	0.00
9	74.62	74.62	49.10	77.43	77.43	52.29	55.70	0.00
10	88.16	85.88	60.80	94.38	89.11	61.44	62.10	85.88
11	79.94	79.94	56.03	88.25	82.96	61.25	59.67	77.88
12	83.29	83.29	56.86	89.67	84.20	60.50	60.56	0.00
13	68.50	68.50	35.83	56.51	71.09	38.16	51.13	0.00
14	84.62	84.62	55.68	82.67	80.53	55.83	57.93	0.00
15	71.75	71.75	50.30	79.32	74.47	51.63	53.57	0.00
16	75.81	73.07	49.89	81.62	73.87	38.22	53.13	69.34
17	72.12	72.12	48.72	76.84	74.85	51.89	53.84	0.00
18	77.61	77.61	52.42	89.06	87.07	60.15	62.41	0.00
19	78.50	78.50	55.02	86.76	81.46	61.44	62.10	76.47
20	74.75	74.75	52.40	52.40	77.58	55.81	55.81	70.19
21	72.96	72.96	48.01	75.71	75.71	51.13	54.46	0.00
22	67.11	67.11	44.17	69.66	69.66	47.05	50.11	0.00
23	85.88	85.88	56.57	88.62	86.81	53.32	55.32	0.00
24	79.29	79.29	55.57	87.63	82.28	59.18	59.18	77.24
25	73.52	71.61	48.91	81.26	0.00	51.53	53.47	0.00

where:

Suitability index	Land class
80-100	highly suitable
60-80	moderately suitable
40-60	marginally suitable,
20-40	currently not suitable, and
0 – 20	permanently not suitable.

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أصل و تكوين و تقسيم بعض أراضى جنوب الوادى (إمتداد الطرفاوى – دبيس)

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تشغل منطقة الدراسة بالجزء الشرقي من مشروع شرق العوينات ويحدها خطي طول ٢٠ ٢٨ و ٤٠ ٢٩ شرقا وخطي عرض ٢٠ ٢٢ و ٣٠ ٢٣° شمالا و يتميز سطح الأرض بوجود أشكال مختلفة ممثلة في السهلين الرملي شبه المستوي والأخر المغطى بالأديم الصحراوي والكثبان الرملية منخفضة الأرتفاع بالأضافة إلى السطوح التموجة والتكشفات الصخرية والتلال المنعزلة.

تهدف الدراسة إلى التعرف على الخواص المميزة للأراضي المتكونة على هذه الأشكال مع التعرف على الوحدات التقسيمية (وفقا للتقسيم الأمريكي) وتقييم مدى صلاحيتها للأستخدام في المجال الزراعي وذلك بتطبيق بعض نظم التقييم المحلية والدولية.

توضح الدراسة أن خواص الأراضي تحت الدراسة تتأثر إلى حد كبير بالظروف المناخية السائدة شديدة الجفاف ممثلة في إرتفاع درجة الحرارة وسرعة الرياح، فضلا على تأثرها بطبيعة مادة الأصل والبناء الجيولوجي والذي يفسر ضعف عمليات التكوين البيدوجينية ، مما يميز هذه الأراضي بخواص طبيعية تتفق مع معايير تضعها في رتبة الأراضي الحديثة Entisols وقد أمكن تحديد ست مجموعات من الأراضي تندرج تحت مجموعات الأراضي *Typic and lithic* لمجموعتي *Torripsamments and Torriothents* ولقد أجري تقييم لأراضي منطقة الدراسة بأستخدام نظم دليل الأنتاجية (Storie, 1963) ونظام PLES-Arid (خليفة 2004) بالإضافة إلى دليل الصلاحية للزراعة المروية (Sys & Verhey, 1978).

تندرج أراضي منطقة الدراسة تحت الأراضي الحدية في أحسن الأحوال. أما عن مدى صلاحية هذه الأراضى لزراعة وإنتاج بعض المحاصيل الحقلية و الخضر وأشجار الفاكهة، فقد تبين أن صلاحيتها تعتبر متوسطة لعدد محدود من المحاصيل ممثلة فى القمح و الشعير و البصل و البرسيم الحجازى و الذى يتمشى مع الواقع الإنتاجى لشركات القطاع الخاص للإستثمار الزراعى بالمنطقة.