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Land Resources in Wadi Hodein Area, Southeastern Desert of Egypt

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Abstract

The Delta of Wadi Hodein in the southern desert of Egypt represents one of the promising areas for sustainable development. Therefore, a great attention has been paid towards the investigation and mapping of the natural resources of this region. The aim of this study is to apply the remote sensing technology to asses and to evaluate an area covers about 550 km^2. Landsat TM data were used to produce geomorphological map at scale of (1:100,000). The main landform units are: beach, coastal plain, marine terraces, sabkhas, alluvial plain, delta plain, alluvial fan, main wadi, tributaries, plain with rock outcrops, hills and mountains and denuded hills. The characteristics of soil were determined. Soils of wadi deposits, alluvial plain and beach were classified as (Typic Torrifluvents, Duric Torrifluvents) Typic Torriorthents, Typic Torripsamments (Typic Aquisalids and Sodic Haplogysids) respectively. A parametric land capability was applied to determine the areas of high potentiality for agricultural development Wadi Hodein region classified as capability classes III, IV and V. The limiting factors in this region are: water resources, climate, light texture (low available moisture holding capacity). The soil found to be suitable for producing wheat, barley, olives, water melon, ground nuts and tomatoes. Due to the limitation of water resource, only few and small areas could be selected to provide local population with the required production. Clean cultivation is highly recommended in order to protect the coral reef and fishing zones.
Keywords: Land resources, Wadi Hodein, Egypt

Introduction

The delta of Wadi Hodein in the southeastern desert of Egypt represents one of the promising areas for sustainable development in the coastal area of the Red Sea. The study area covers about 550 km^2 (132.000 Fed.) and is located between 23° 00′ and 23° 10′ N latitudes and 35° 15′ and 35° 40′ E longitudes, Fig. (1). The climatic condition is arid with winter thunder storms on the adjacent mountainous area reaches about 30 mm/day, causing very severe flash floods. Mean temperature is about 31 °C in summer, and 20 °C in winter. No agriculture activities were noticed in the area. Human activities are mainly grazing and fishing. Some geological and hydrological investigations about this area and concluded that: a- ground water resources can be present in four types of rocks (Fractured basement, Nubian cretaceous sandstone, Miocene limestone and Wadi deposits). b- the groundwater of the Fractured basement is considered the best water quality while, the groundwater of the Deltas and Wadis are highly saline (5000-17000 ppm) due to sea water intrusion and the presence of old saline sediments and evaporates. Few studies have been published about this area are mainly focused in the geology and mineral resources (El-Rakiby et al., 1996,

Zaghloul, 1996, Abdel Rahman, 1997a & b). Some main Wadis have high potentiality of run off water (wadi Hodein and Rahba), which must be managed by construction of some dams and dikes. The aim of this study is to represent the assessment and evaluation of land resources using remote sensing technique.

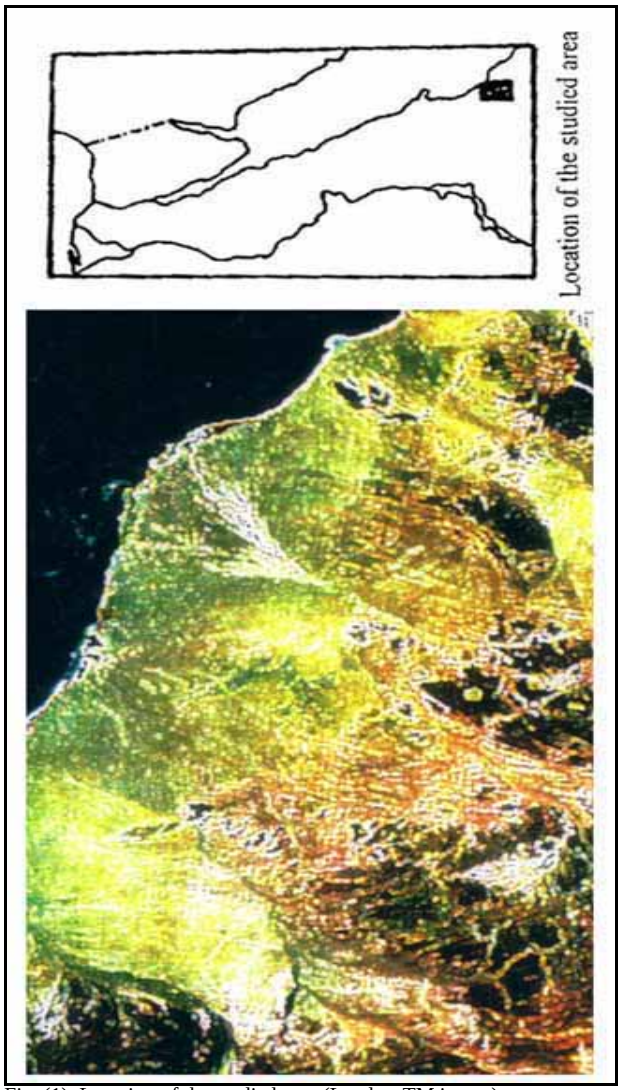

Fig. (1): Location of the studied area (Landsat TM image).

Environmental setting

General description of the morphological features of satellite image, Fig. (1) could be summarized in the following:

a- Geomorphology: Landforms of this area are divided into four groups: the bahada plain, faulted mountains, hills and coastal forms and wadis. The. bahada plain is formed by the alluvial delta of the wadi Hodein and Rahba and some other smaller wadis. Drainage lines are dissecting. Faulted mountains and hills are located specially in the southwestern part (G. Zakrob El-Tahtani, 829 m). Sabkhas are the forms that developed along the Red Sea coast.

b- Geology: Quaternary deposits include the fluvial sediments of the bahada and the coastal sediments of the barriers and sabkha. Faulted mountains and hills are formed of basement and volcanic rocks. Pink "younger" granite, while metamorphic and gray granite dominate in the area. Basement rock may contain mineral ores such as Titanium.

C- Soils, water aquifers and vegetation: Soils are either of fluvial or sabkha origin. The fluvial soils are those of the bahada and are coarse textured. The sabkha soil is composed of medium or fine material and is always damp with high percentage of salt content. In these sediments, shallow aquifers of underground water are developed, whereas another type of shallow aquifers is formed in the mountains. Both types are fed by rain water, Underground water is scarce in this area and some wells such as Bir Hutit exploit the basement aquifer. Salt-tolerant vegetation grow up along the coastal strip around the sabkha margins and wadi mouths, while dense natural vegetations are noticed in the main wadi depending on the shallow aquifer water from the fluvial sediments.

Land quality and soil characteristics

Land evaluation systems are mostly interpretative classifications relevant to agricultural management and planning. They normally evaluate the land in various categories, each is corresponding to certain level of details, Storie (1937), Klingebiel and Montgomery (1961). A numerical land capability model was used to classify the mapped land units according to its capability for agricultural production. The main land parameters considered for capability classification are: climate, wetness, salinity and sodicity, slope and erosion hazard, rootable depth, available moisture holding capacity and calcium carbonate content. Table (1) shows the relation between the calculated capability index of the evaluated land units, capability class and grade. The capability indices for each land units are calculated using Storie formula:

$$Cl = A.\frac{B}{100}.\frac{C}{100}.\frac{D}{100}$$

Where:

Cl: capability index, and A, B, C are the rating of various land parameters.

Table (l): Capability class, Grade and Capability index range.

Capability class	Grade	Capability index
I	Very good	80-100
II	Good	60-79
III	Fair	40-59
IV	Poor	20-39
V	Very poor	10-19
VI	Non- Agric.	<10

Materials and Methods

- Satellite image: Landsat-5 Thematic Mapping data cover the study area were used. The data was collected in 6/7/1993 and scene carrier was. Path (173), Row (44) Fig. (1).
- Digital image processing: The distributing technique was used to improve the quality of data which are received from the ground receiving stations. Geometric correction using number of control points in the available topographic maps of the area. Mosiking, radiometric balance and high pass filer methods were used to improve the final products of the false colour composites (FCC) bands 2, 4 and 7, which were used for visual interpretation. Non supervised and supervised classification techniques were used to discriminate between the different soil types within the mapped units.
- Soil profiles selection and soil characterization: Representative forty two soil profiles were selected and described in the field according to FAO (1990). Soil samples were analysed for soil characterization using the methods of USDA (1984). The soils were classified according to Soil Survey Staff (2003).
- Land evaluation: A parametric and capability classification system were applied to evaluate the existing land resources for agricultural use, Younes, et al (1995) and finally, a land capability map of the area is produced (Fig 4). A Soil suitability model (Abdel Rahman et al., 1989) was performed.

Results and Discussion

l- Assessment and Mapping of Land Resources

The interpretation of Landsat Thematic Mapper Data, FCC 2,4,7 found to be very useful for producing thematic map show the main landform units, soil types and drainage pattern of Wadi Hodein. A soil map at scale of 1:100,000 was produced based on a topographic map of the same scale (Fig. 2).

Visual interpretation of remote sensing data reveals the presence of the following landform units: beach, coastal plain, marine terraces, sabkhas (wet and dry), alluvial plain, delta plain, main wadi, tributaries, alluvial fan, plain with rock outcrops, denuded hills finally hills and mountains, (Fig. 2).

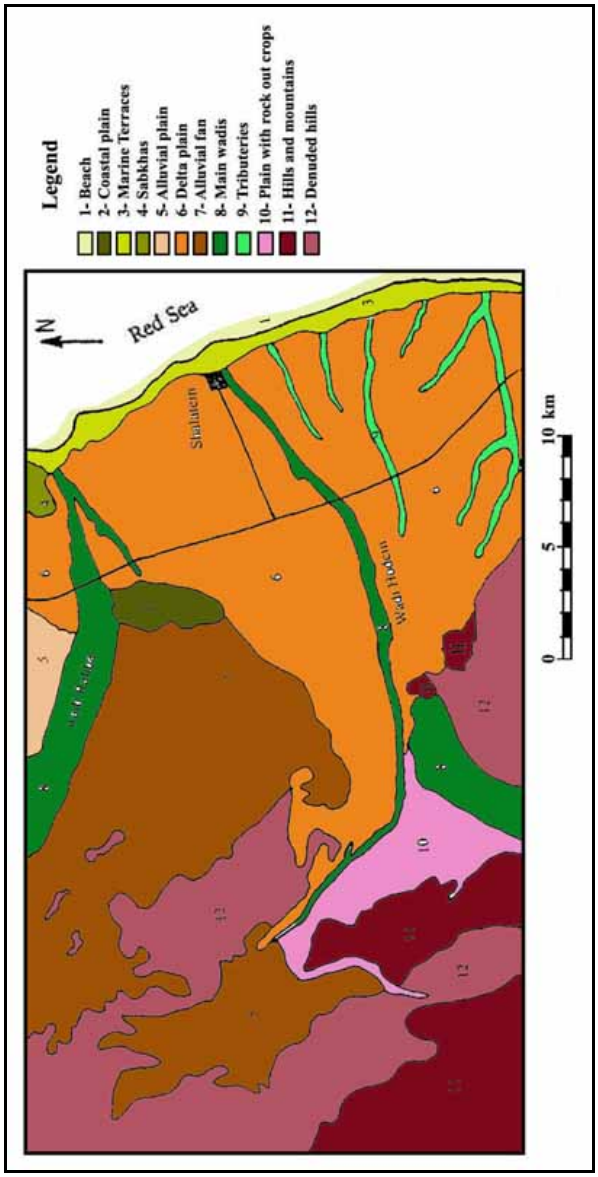

Fig. (2): Geomorphological and soil units of Wadi Hodain area.

Field investigations include terrain analysis and sampling of the soils for laboratory analysis were carried out for each of the forenamed land units.

Table (2): Some soil characteristics of the selected soil profiles.

Land unit	Depth (cm)	pH	EC dS/m	$CaCO_3$ %	Gravel %	Particle size distribution						Textural class	CEC meq/ 100 gr
						V.C.S	C.S	M.S	F.S	V.F.S	Si+C		
Beach	0-20	7.8	17.2	2.2	30.2	26.2	18.4	20.1	25.5	6.2	3.6	GCS	2.8
	20-60	7.7	17.9	3.2	42.1	29.8	15.9	21.0	28.8	4.9	0.6	GCS	0.5
	60-80	7.6	26.3	3.9	32.5	33.1	19.4	19.2	5.5	5.5	3.3	GCS	2.6
Coastal plain	0-15	8.7	1.9	2.8	23.7	12.0	9.0	14.1	41.6	20.3	3.0	FS	2.3
	15-45	8.4	0.9	1.5	14.0	20.1	10.1	19.1	30.5	18.1	2.1	MS	1.6
	45-100	8.5	0.2	1.8	7.1	21.5	13.8	18.4	26.2	16.2	3.9	MS	3.0
Marine terraces	0-25	7.4	100.0	2.1	9.4	18.6	25.0	33.9	18.7	2.0	1.8	CS	1.4
	25-50	7.3	48.0	0.6	25.3	41.7	20.1	15.2	8.0	10.0	5.0	GCS	3.9
	50-85	7.6	21.5	1.4	38.9	4.0	9.5	39.0	42.2	4.9	0.4	GMS	0.3
Sabkhas	0-20	7.4	44.0	3.2	31.6	22.4	19.0	27.6	24.5	6.0	2.5	GCS	2.5
	20-40	7.6	23.0	1.4	0.0	15.2	11.2	19.1	33.0	15.0	6.2	FS	4.8
	40-60	7.7	35.0	12.2	0.0	28.0	16.2	20.2	20.5	7.2	1.9	CS	1.5
Alluvial plain	0-35	8.6	0.2	2.1	7.8	8.2	4.7	12.3	60.0	12.8	2.0	FS	1.6
	35-80	9.0	0.2	2.9	2.8	7.2	10.9	24.8	43.5	9.1	4.5	FS	3.5
	80-100	8.4	0.9	2.0	1.5	2.2	2.7	28.9	57.9	5.5	2.8	FS	2.2
Delta plain	0-35	9.2	0.2	2.4	6.7	21.7	165	17.4	28.2	13.4	2.8	FS	2.2
	35-65	9.3	0.2	3.0	26.1	23.4	21.0	26.0	23.0	5.3	1.3	GCS	1.0
	65-110	9.2	0.3	2.2	24.2	24.5	16.7	27.6	16.9	7.6	3.7	MS	2.9
Alluvial fan	0-30	8.7	0.2	1.9	12.0	5.0	12.1	35.2	39.6	6.4	1.7	MS	1.3
	30-70	8.8	6.2	1.4	30.9	25.0	25.2	30.6	15.2	3.1	0.9	GCS	0.7
	70-100	8.3	2.3	2.7	12.3	18.7	30.7	40.2	9.5	0.7	0.2	CS	0.2
Main wadi	0-20	9.1	0.5	1.8	11.3	9.7	11.9	18.6	42.8	14.7	2.5	FS	2.0
	20-65	8.4	2.6	4.8	12.0	16.0	21.6	33.4	24.6	3.8	0.6	CS	0.5
	65-110	8.5	2.0	4.7	8.8	31.1	21.9	36.3	23.8	3.5	1.4	CS	1.1
Tributaries	0-20	8.2	2.8	1.8	59.3	28.3	23.8	26.8	15.8	4.4	0.9	VGCS	0.7
	20-50	8.1	6.0	3.6	46.7	32.7	23.4	21.9	19.0	2.4	0.6	GCS	0.5
	50-80	8.2	2.6	1.1	44.8	46.6	22.4	17.7	6.4	1.4	0.5	GCS	0.4
Plain with rock Outcrops	0-25	8.1	0.9	3.6	58.5	8.0	7.9	22.5	48.4	9.1	4.1	VGMS	3.2
	25-70	7.7	6.7	5.4	53.6	35.1	13.2	18.0	21.5	5.8	6.4	VGCS	5.0
	70-100	7.6	13.6	3.9	59.1	25.1	17.2	13.9	26.4	11.2	6.2	VGCS	4.8

Where: V= very G= gravely F= fine Si + C= silt + clay
M= medium C= coarse S= sand

The main soil characteristics of some potential land units in the study area were classified in Table (2), and the soil is classified according to Soil Survey Staff (2003) to the subgroup level as follows: Moderately deep to deep, slightly to moderately calcareous and slightly saline soils of wadi deposits were classified as Typic Torrifluvents. Deep, slightly calcareous and slightly saline soils of the alluvial plain were classified as Typic Torriorthents. Extremely salt affected soils of marine terraces and sabkhas were classified as Typic Aquisalids and Sodic Haplogypsids, Fig. (3).

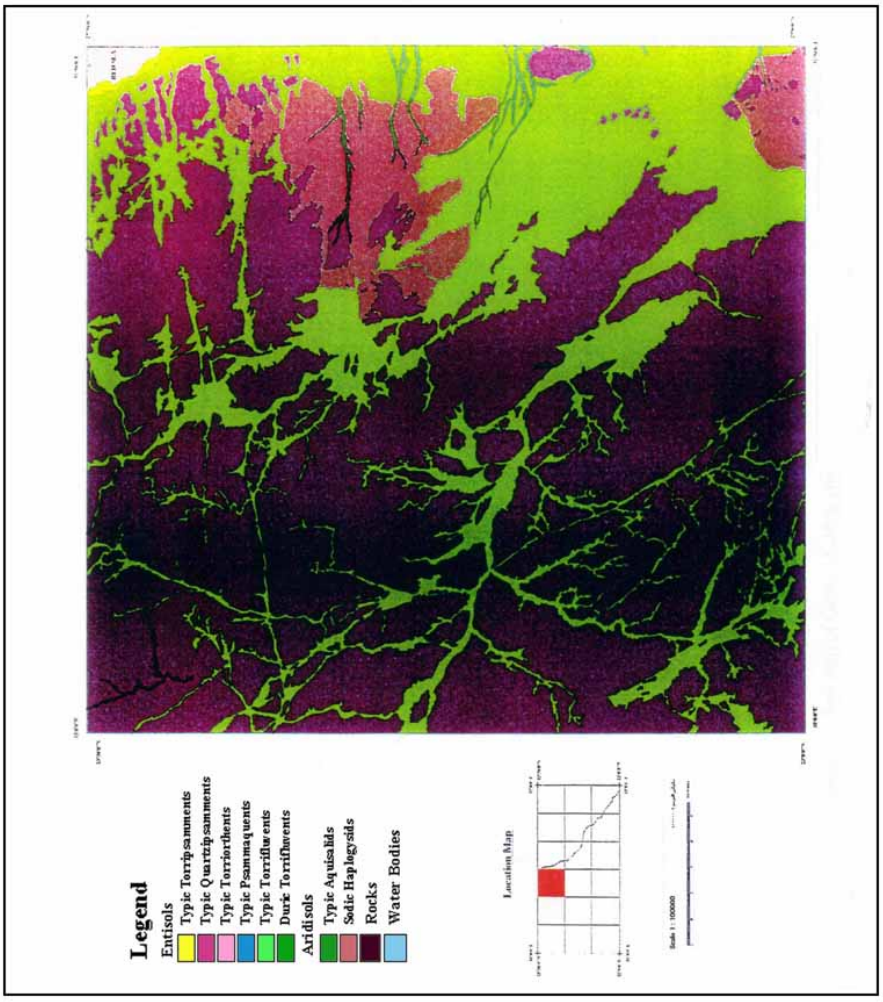

Fig. (3): Soil map of Wadi Hodain area.

2- Land Evaluation

The primarily evaluation of the mapped land units using a parametric land capability classification model reveals that Wadi Hodein area is capable for sustainable agriculture development. The most soils of Wadi Hodein area are classified as capability classed III and IV. The marine terraces and tributaries considered very poor and non- agricultural land (classes V, VI). Soils of the wadis, deltas, alluvial plain, alluvial fan, coastal plain were suitable for agricultural production under proper management of flat floods, which represent the main water resources in this region and these soils are classified as capability classes III and IV, Fig (4). The main limitation for development in this region were the severe climatic conditions and light (coarse) texture (low available moisture holding capacity), Table (3).

The soils are found to be suitable for producing wheat, barley, olives, water melon, ground nuts and tomatoes. Due to the limitation of water resources, few small areas were selected for producing agriculture products to support the local people.

In order to protect the coral reef and fishing zones in the coastal area which have high economic values, clean cultivation (free from chemicals) is recommended.

Table (3). Land capability classification of Wadi Hodein area.

Land unit	Capability class	Limiting factor
Beach	VI	c, t, w, s, d
Coastal plain	III, IV	c, t,
Sabkhas	IV, V	c, t, W, S
Marine terraces	V, VI	c, t, s, d
Alluvial plain	III, IV	c. t
Alluvial fan	III, IV	c, t
Delta plain	III, IV	c, t
Main wadis	IV	c, t
Tributaries	V	c, t, d
Plain with rock outcrops	IV	c, t

Where: c= Climate, w= wetness, t= texture, e=: erosion, s= salinity , d= soil depth

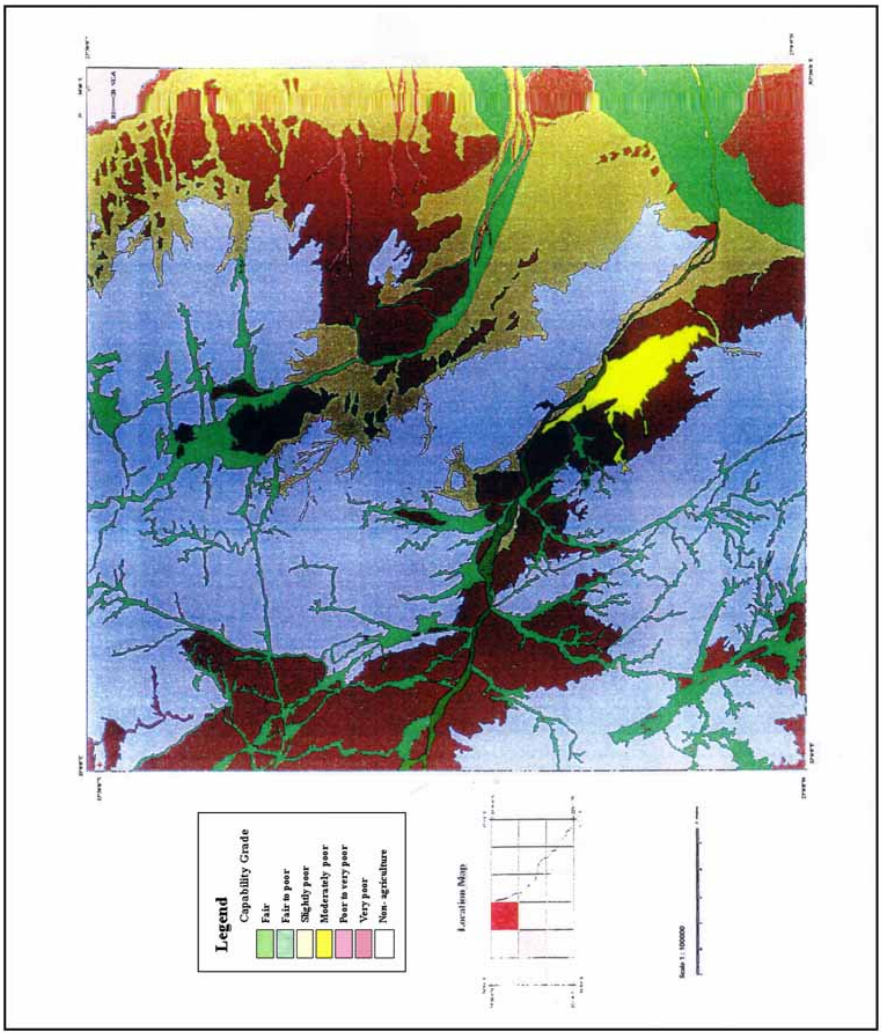

Fig. (4): Land capability map of Wadi Hodain area.

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الموارد الأرضية في منطقة وادي حوضين في جنوب شرق مصر

محمد إبراهيم أحمد الطويل و مصطفى محمد قطب

قسم الأراضي واستغلال المياه – المركز القومي للبحوث – القاهرة – مصر

– تم اختيار منطقة وادى حوضين بمثلث حلايب والشلاتين فى جنوب شرق مصر وذلك لحصر وتقييم الموارد الأرضية بها.

– تم فحص ودراسة (42) قطاع أراضى وإنتاج خريطة توضح الوحدات الجيومورفولوجية بالمنطقة ومعرفة مدى قدرتها الإنتاجية.

– قسمت أراضى المنطقة تبعا للنظام الدولى الأمريكى لتصنيف التربة (2003), حيث وجد أن أراضى الوادى تتبع تحت مجموعة الـــ Typic Torrifluvents بينما أراضى السهل الرسوبى فإنها تتبع تحت مجموعة الـــ Typic Torriothents أما أراضى الشرفات البحرية والسبخات والمتأثرة بالأملاح لقربها من ساحل البحر فإنها تتبع تحت مجموعتى Typic Aquisalids, Sodic Haplogypsids.

– وجد أن أراضى الوادى الرئيسى والسهل الساحلى الفيضى والسهل الدلتاوى والمراوح الرسوبية ذات قدرة إنتاجية عالية نسبياً حيث تتبع الدرجة الثالثة والرابعة بينما أراضى الشرفات البحرية والأودية الفرعية فكانت ذات قدرة إنتاجية منخفضة حيث تتبع الدرجة الإنتاجية الخامسة والسادسة.

– وجد أن أهم العوامل المحددة للإنتاجية بهذه المنطقة تتلخص فى ندرة مصادر المياه, المناخ, القوام الخشن مما ينعكس على قدرة الأرض على الاحتفاظ بالماء.

– باستخدام نظام القدرة الإنتاجية الملائمة لمحاصيل معينة, وجد أن أنسب المحاصيل بهذه المنطقة هى القمح والشعير والزيتون والبطيخ والفول السودانى والطماطم وذلك اعتماداً على مياه السيول والآبار أو مياه البحر بعد تحليتها وذلك فى مناطق مخارج الوديان.

– يجب أن تنحصر الزراعة فى مساحات صغيرة عند مخارج الوديان الرئيسية وذلك لتوفير الاحتياجات للسكان المحليين.