Land Capability Classification in Wadi Qena, Upper Egypt

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Introduction

Wadi Qena is one of the areas included in a scheme aimed at expanding the amount of cultivable soil in Egypt. Many studies have been carried out in this region to investigate the soils and water resources (MEHANNY, 1966; ABDEL HADY, 1987; EL SAWY et al., 1990). However, few studies were focused on the capability and suitability of Wadi Qena soils for crop production (HANNA, 1986).

The Land Capability Classification system was proposed and reported by KLINGEBIEL and MONTGOMERY (1961). In this system, the arable lands are grouped according to their potentialities and limitations for permanent vegetation and according to the risks of soil damage if mismanaged. STORIE (1964) used a modified equation to calculate indices for rating the lands for agricultural use.

The most widely used scheme of land evaluation is the FAO framework (FAO, 1976). Two groups of properties or attributes form the basis of this system: land characteristics and land qualities. The framework for land evaluation has been further developed in the agroecological zones concept (FAO, 1978). The comprehensive general system for land evaluation discussed by SYS (1985) can be applied in various ecological types.

BUROUGH (1986) highlights the complexity of the data management problems encountered in the evaluation of land resources. ROSSITER and VAN WAMBEKE (1989) introduced the Automated Land Evaluation System (ALES) as a computer programme that allows land evaluators to build an expert system to evaluate lands according to the method presented by FAO (1976). On the same basis, ABDEL RAHMAN et al. (1989) prepared a computer programme to examine the suitability of soils under arid conditions for cultivation with 20 crops. Soil survey data and crop requirements are the main attributes used in their system, which has been applied to evaluate the soils of many regions in Egypt (ABDEL KADER et al., 1991; MOAWAD et al., 1991; LABIB et al., 1991).

ABDEL RAHMAN (1992) and GAD (1992) used the System Analysis for Agricultural Development Alternatives model (SAADA) for producing soil productivity maps of old cultivated land in Idfu and Assuit, respectively. The SAADA model was developed by NELSON et al. (1978) to determine soil bodies, methods and cost of reclamation, and land classes according to the USDI (1953) system.

The aim of this paper is to evaluate the soil of Wadi Qena, Upper Egypt, and to determine the crops suitable for cultivation in newly-reclaimed areas.

Materials and Methods

The investigated site (deltaic mouth of Wadi Qena) is located at latitude 26°8' to 26°14' N and longitude 32°12' to 32°15' E. It covers about 5000 feddans of desert alluvial fan. The study area is formed of Nile alluvium near to the river, with alluvial materials derived from the denudation of the Red Sea mountains at the far end. The Qena Valley is located in a desert climatic region with annual mean values as follows: 33.5 °C maximum temperature, 16.40 °C minimum temperature, 24.95 °C average temperature; 5.50 mm rainfall, 49% relative humidity and 8 mm evaporation.

Field observations, sampling and soil characterization were carried out according to the methods outlined in USDA (1984).

Seventeen soil profiles distributed over the study area and representing the different land forms were investigated. The study area was divided into three parts, namely: rubble terraces (upper A), wadi plain (middle B), and interference zone (lower, C).

All the data available after the soil survey, in addition to other information about climate, water resources, crops requirements, and socio-economic aspects, were used to evaluate the Wadi Qena soils.

Two land classification systems were used in this study: Land Capability Classification (USDA, 1961), and Soil Suitability for Certain Crops (ABDEL RAHMAN et al., 1989).

Results and Discussion

Soil characteristics

17 soil profiles were studied in the field and soil samples were collected and analyzed to determine the main physical and chemical characteristics. Table 1 shows the soil properties of some representative soil profiles se-lected on the basis of Landsat TM data.

Generally, the soil colour is very pale brown to light yellowish in the upper and middle parts, changing to dark yellowish brown in the lower part. The

Table 1

Soil characteristics of some sites studied

Zone and Profile No.	Depth, cm	Morphological characteristics			Texture Class	Gravel %	EC, mmhos/cm	pH 1:2.5	Org. matter, %	$CaCO_3$ %
		Colour	Structure	Land use						
Rubble terrace* *5.	0 - 15	10 YR 8/4	Single grain	barren	sandy	24.50	0.63	7.8	0.15	16.10
	15 - 30	10YR 7/4	Single grain	barren	sandy	28.10	0.61	8.0		19.35
	30 - 100	7.5YR 8/4	Single grain	barren	sandy	24.0	0.61	8.0		16.47
***Wadi plain* 7**	0 - 20	10YR 7/3	Single grain	barren	sandy	11.80	0.85	8.0	0.10	21.60
	20 - 50	10YR 6/4	Single grain	barren	sandy loam	3.93	0.84	8.0		10.80
	50 - 100	10YR 6/4	Single grain	barren	sandy loam	1.75	0.60	7.9		8.73
13	0 - 25	10YR 7/3	Single grain	barren	sandy loam	15.30	2.10	7.8	0.35	18.07
	25 - 55	10YR 7/4	Single grain	barren	sandy	43.17	1.35	7.9		7.64
	55 - 100	10YR 7/4	Single grain	barren	sandy	16.62	0.80	8.2		6.50
***Interfer. zone* 16**	0 - 20	10YR 6/3	Granular	F. crops	silty loam	11.23	3.44	8.0	1.20	20.10
	20 - 60	10YR 6/3	Granular	F. crops	silty loam	10.41	3.50	8.2		19.85
	60 - 100	10YR 6/4	Granular	F. crops	silty clay l.	-	3.35	8.0		23.62
17	0 - 30	10YR 4/4	Granular	F. crops	silty loam	-	1.49	7.9	1.62	3.12
	30 - 65	10YR 5/4	Granular	F. crops	silty clay l.	-	1.62	8.3		2.68
	65 - 100	10YR 4/4	Granular	F. crops	silty clay l.	-	2.63	8.4		2.24

soils have a high gravel content in the upper parts, decreasing lower down. The soils are structureless sandy loam to loamy sand soils, having many coarse lime concretions. The soils are very poor in organic matter content with pH values between 7.5 and 8.85. Soil salinity varies from one site to another depending upon the elevation and the topography.

Soil classification

According to the Soil Taxonomy published by USDA (1975), the soils of Wadi Qena could be classified and grouped in four subgroups belonging to two orders: Aridisols and Entisols

Typic Calciorthids represent most of the soils in the study area and are concentrated mainly in zone (B), while Typic Torrifluvents and Duriorthidic Torrifluvents were the dominant subgroups in the lower part (zone C). On both sides of the wadi, on the relatively elevated rubble terraces, the soils were classified as Typic Torripsamment.

Land evaluation

Two land classification systems were used to classify the soils of Wadi Qena into groups of soils that have similar suitability for crop production. These were the Land Capability Classification of the USDA Soil Conservation Service (1958-1973) and the Soil Suitability Classification proposed by SYS (1985) and adapted by ABDEL RAHMAN et al. (1989) to suit Egyptian conditions.

The capability classification is one of a number of interpretive groupings made primarily for agricultural purposes. The arable soils of Wadi Qena were grouped into four capability classes according to their potentialities and limitations for the sustained production of common cultivated crops that do not require specialized site treatment.

The kinds and degrees of limitation affecting the capability classification of Wadi Qena soils were presented in Table 2.

The area represented by profile No. 17 (zone C) has no or only slight limitations. Therefore, it could be classified as capability class 1. No soil or climatic limitations could be identified in these nearly level, irrigated, deep, non-saline, non-alkaline, non-calcareous loamy soils. The soils represented by profile No. 16 (zone C) were classified as capability class II, consisting of irrigated, deep, slightly saline, calcareous sandy clay loam soils subjected occasionally to erosion. It therefore falls into subclass (e), and in some areas into subclass (s) due to subsoil limitations.

The deep, sandy, slightly saline, calcareous soils, having surface crust and a rich gravel content (in the upper and middle zones) were considered as capability class IV. The lands of site 5 have severe subsoil limitations (s) and severe

Table 2

Some soil parameters and limitations (kind and degree) used in land evaluation

Profile No.	Texture class	Gravel %	$CaCO_3$ %	Depth to calcic hor. cm	Salinity, mmhos /cm	ESP	Slope %	Organic matter, %	Climate	Subsoil	Erosion	Water holding capacity
1.	14	13.70	18.88	-	2.04	2.68	5	0.06	S	N	N	N
2.	12	34.13	17.63	-	0.99	1.11	3	0.10	S	S	S	N
3.	13	23.03	15.96	15	6.13	4.43	2	0.01	S	S	S	N
4.	17	36.67	22.58	-	1.63	0.66	3	0.10	S	S	N	N
5.	6	26.13	16.20	15	0.75	0.27	3	0.10	S	S	S	S
6.	12	14.11	15.64	30	1.87	2.66	2	0.02	S	N	N	N
7	12	5.78	18.49	20	0.75	1.30	2	0.05	S	L	N	N
8.	18	6.17	22.38	-	4.93	1.31	2	0.08	S	L	N	N
9.	15	4.14	21.59	30	5.72	8.29	2	0.46	S	L	N	N
10	6	43.09	12.18	15	3.87	2.34	3	0.01	S	S	S	S
11.	6	35.02	7.04	30	6.40	3.09	3	0.03	S	S	S	S
12.	15	8.02	23.57	5	1.08	1.73	2	0.55	S	L	N	N
13.	9	26.0	9.78	10	1.28	1.61	2	0.47	S	S	S	S
14.	9	24.63	14.07	-	1.82	1.71	2	1.12	S	S	N	S
15.	24	7.63	21.20	-	2.24	1.69	2	1.23	L	L	L	F
16.	30	6.33	20.62	-	3.31	6.57	2	1.14	L	L	L	F
17.	30	-	2.79	-	1.84	5.91	1	1.46	L	L	L	F

L: low; M: moderate; S: severe; F: favourable climate limitations (c). On the area represented by site 13, the land has climatic limitations (c) and subsoil limitations (s). In addition, many other limitations of different degrees are found in this region. the presence of a high amount of gravel and stones, salinity and low moisture holding capacity were other limitations affecting the capability of these soils.

In the middle zone, site 7, the land has few limitations to restrict the amount of clean cultivation and choice of crops. Therefore, it has been classified as capability class III, with subclasses (e) and (s).

A similar conclusion was drawn by HANNA (1986) in a reconnaissance soil survey study of Egypt (Land Master Plan Project). He classified the soil of Wadi Qena as class IV according to the USDI Classification System (SCS, 1953).

For the identification of capability units, which represent areas with similar potentiality for growing certain crops, another land classification system was employed as discussed below.

The Soil Suitability for Certain Crops programme was used to calculate the suitability indices of 20 crops for cultivation in Wadi Qena. It is based on matching soil properties with crop requirements. This system can provide information about soil suitability for each soil rather than each site. Therefore, the log data obtained could be used to classify the study area according to capability units. The data in Table 2 show, in addition to the different kinds and degrees of limitations, the main soil attributes used in this classification and the general soil characteristics of each profile (soil log).

The suitability indices of the soils for different crops are presented in Table 3. The data show that the suitability indices of the soils in the lower part of the area studied were very high, indicating the suitability of these soils for most of the crops tested. The soils of lower quality in the middle and upper regions exhibit low suitability indices which varied from one site to another. The data also show a positive relation between the results obtained from the two land classification systems used in this study.

Summary

An evaluation of about 2000 hectares located in Wadi Qena, Upper Egypt, was carried out using two land evaluation systems: the Land Capability Classification (LCC) as a qualitative system based upon the degree and kind of limitations, and the Soil Suitability for Certain Crops (SSCC) model, based on matching soil characteristics with crop requirements and water resources (availability and quality). The two systems were used in an integrated manner to determine both the areas and the crops with the aim of agricultural expansion in the wadi region.

Table 3

Capability classes, capability subclasses and suitability indices of different crops in the profiles studied

Crop	Profile No.																
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
Wheat	0.57	0.36	0.37	0.61	0.23	0.61	0.57	0.71	0.51	0.22	0.18	0.71	0.33	0.80	0.80	0.72	0.72
Clover	0.30	0.36	0.09	0.61	0.23	0.61	0.57	0.17	0.14	0.11	0.04	0.71	0.36	0.80	0.42	0.42	0.89
Sugar cane	0.54	0.36	0.35	0.49	0.23	0.61	0.45	0.71	0.48	0.24	0.23	0.64	0.36	0.80	0.85	0.76	0.80
Rice	0.46	0.29	0.30	0.49	0.19	0.49	0.45	0.56	0.45	0.18	0.15	0.57	0.29	0.64	0.64	0.64	0.71
Onions	0.57	0.36	0.37	0.61	0.23	0.61	0.57	0.71	0.51	0.22	0.19	0.71	0.36	0.80	0.80	0.72	0.80
Corn	0.30	0.36	0.09	0.61	0.23	0.61	0.57	0.17	0.14	0.11	0.04	0.71	0.36	0.80	0.42	0.42	0.89
Cotton	0.63	0.47	0.43	0.57	0.33	0.71	0.54	0.80	0.56	0.34	0.33	0.72	0.47	0.90	0.95	0.85	0.89
Sorghum	0.73	0.47	0.45	0.71	0.33	0.71	0.67	0.83	0.59	0.30	0.25	0.80	0.42	0.90	0.90	0.81	0.81
Millet	0.66	0.47	0.45	0.71	0.33	0.71	0.67	0.79	0.49	0.31	0.27	0.80	0.47	0.90	0.90	0.67	0.74
Groundnuts	0.42	0.47	0.11	0.66	0.33	0.85	0.83	0.20	0.17	0.16	0.07	0.90	0.49	0.95	0.50	0.45	0.99
Carrots	0.42	0.47	0.11	0.66	0.33	0.85	0.83	0.20	0.17	0.16	0.07	0.90	0.49	0.95	0.50	0.45	0.99
Potatoes	0.33	0.47	0.05	0.33	0.33	0.85	0.41	0.14	0.01	0.18	0.07	0.72	0.49	0.95	0.50	0.45	0.99
Watermelon	0.79	0.47	0.45	0.66	0.33	0.85	0.83	0.83	0.71	0.31	0.27	0.90	0.47	0.95	0.95	0.85	0.94
Tomatoes	0.79	0.47	0.45	0.66	0.33	0.85	0.83	0.83	0.71	0.31	0.27	0.90	0.47	0.95	0.95	0.85	0.91
Citrus	0.31	0.47	0.09	0.57	0.33	0.71	0.54	0.16	0.13	0.17	0.06	0.72	0.47	0.90	0.47	0.47	0.99
Grapes	0.59	0.47	0.36	0.57	0.33	0.71	0.54	0.67	0.47	0.33	0.27	0.72	0.47	0.90	0.90	0.81	0.89
Olives	0.59	0.47	0.36	0.57	0.33	0.71	0.54	0.67	0.47	0.33	0.27	0.72	0.47	0.90	0.90	0.81	0.89
Figs	0.73	0.47	0.45	0.91	0.33	0.71	0.67	0.83	0.59	0.30	0.25	0.80	0.42	0.90	0.90	0.81	0.81
Sunflowers	0.66	0.47	0.45	0.71	0.33	0.71	0.67	0.79	0.66	0.31	0.27	0.80	0.47	0.90	0.90	0.90	0.99
Beans	0.79	0.47	0.45	0.66	0.33	0.85	0.83	0.83	0.79	0.31	0.27	0.90	0.47	0.95	0.95	0.95	1.00
Capability class	III	IV	IV	III	IV	III	III	III	III	IV	IV	III	IV	II	II	II	I
Capability subclass	c,e	c,s,e	c,s,e	c,e,s	c,s,e	c,e	e,c	e,c	e,c	s,e,c	s,e,c	e,c	s,e,c	c,e,s	c,e	c,s	-

17 representative soil profiles from the study area were collected, analyzed and evaluated. The data obtained revealed the presence of four capability classes with three capability subclasses. The determination of the capability units reflects the heterogeneity of the region. Soil depth, texture, salinity, and slopes differed from one location to another in the study region.

The soils of Wadi Qena could be classified according to the Soil Taxonomy system as Typic Calciorthids in the wadi plain. Typic Torrifluvents in the rubble terraces, Duriorthidic Torrifluvents in the interference zone, and Typic Torripsamments in the river terraces.

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