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Evaluation of Soil Agricultural Productive Capability by Using Remote Sensing and GIS Techniques in Siwa Oasis, Egypt.

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ABSTRACT

Siwa Oasis represents one of the most important depressions in the western desert of Egypt. This importance comes from the availability of water resources, which can be used in land reclamation and cultivation projects. Accordingly, the main objective of this work was to evaluate agricultural productivity of soils in Siwa Oasis. For that purpose, 20 geo-referenced soil profiles were dug and sampled based on their development. Forty sixsoil samples were collected from these profiles and analyzed for their physiochemical properties. Water samples were also collected from irrigation wells and drainage canals. These samples were analyzed for their chemical properties. Land evaluation was carried out using the Agriculture Land Evaluation System for arid and semi-arid regions (ASLEarid). The obtained results indicated that soils in SiwaOasis were set into two classes (fair and poor) based on soil index. Also, they were located into three classes (fair, poor and very poor) based on fertility index. Water quality was good for crop irrigation. The final land capability was fit into classes (Fair and poor). Fair soils represented about 70% of the studied area and poor soils represent the rest of the area. Poor land capabilities were mainly attributed to high soils salinity, coarse texture, low fertility and poor drainage. However, these limitations can be eliminated through proper management practices. The suitability of soils in the oasis was also evaluated for 18 crops. Soils suitability ranged between suitable and permanently unsuitable.

Key words: Soil evaluation, Land capability, Land suitability, ASLEarid, GIS.

INTRODUCTION

Nowadays, the availability of more accurate soil information at larger scales is very critical for their management and sustainability. Systems used in studying soil spatial variability and evaluating land capability have been developed over the last decades(Sys et al., 1991; FAO, 2007). Land evaluation is the process used for predicting land use based on its attributes, where a variety of analytical models can be used in these predictions, ranging from qualitative to quantitative (Rossiter, 1996). The conventional methods were focused on studying spatial variability among soil properties and reporting these variations in soil survey reports. The boundaries between soil map units are delineated depending on the characterization of soils properties and their interpretations from a pedological point of view. On the other hand, the current methods employ recent developments in computer science, GIS and data acquisition technology in developing computerized knowledge-based systems for land evaluation. Extensive information about soil physical, chemical and fertility characteristics are integrated in these systems(Khallifa, 2008; Rasheed et al., 2008;Dengiz and Sağlam, 2012; Digby Wells Environmental, 2015). This is in addition to other critical information for crop productivity such as water quality, climatic conditions, and environmental factors. ALES, LECS and ASLEaridare some examples GIS-based land evaluation system (Sys et al., 1991;Ganzorig, 1995; Ismail et al., 2012).

Although, there are about 24 elements necessary for plant growth, nitrogen, phosphorus, and potassium (NPK) are the primary nutrients for plant growth. The insufficiencies of these primary nutrients are mostly responsible for limiting crop growth and productivity. Moreover, the capability of a soil to be produce crops depends on soil physical, chemical and biological characteristics. For instance, soil organic matter content, texture, depth, pH, and water-holding capacity; they all have a great influence on soil fertility. These properties differ among soils and accordingly soils vary in their productivity.

Assessment of land suitability for agriculture use is meant to evaluate the ability of a certain piece of land to provide the optimal ecological requirements of a certain crop. In other words, assessing the capability of land is enabling optimum crop development and maximum productivity. When the economic conditions are ignored, a physical suitability evaluation reveals the degree of suitability for a certain land use (Darwish et al., 2006; Baniya, 2008). Soils in Siwa Oasis have a great potential for land reclamation projects due to the availability of water resources for crop irrigation. Evaluating the capability of these soils for agricultural production,is very critical as well as their suitability for some potential crops.

Accordingly, the main objectives of this work were to evaluate land capability of soils in Siwa Oasis and to make an assessment of their suitability for some potential crops. Developing land capability and suitability maps of soils in Siwa Oasis well help in establishing a decision making framework for future planning of the that region.

MATERIALS AND METHODS

Site description

Siwa Oasis represents one of the most important natural depressions in the western desert of Egypt. It covers an area of about 1100 km^2; however the studied area is about 521 km^2. It is located between latitudes 29^{o}6' 10.14"- 29^{o} 18' 36.24" N and longitudes 25^{o} 16' 2.36" to 25^{o} 51' 3.04" Eas illustrated inFig. 1. It is located at about 300 kilometers south of the Mediterranean Sea at the western borders with Libya.

The total numbers of inhabitants in Siwa were about 21482 residents in 2006.

It has an elevation of about 23m below sea level (BSL). The mean annual temperature varies from 5.8 ^{o}C in January to 37.8 ^{o}C in July. The minimum soil mean temperature is 13.3 °C in January, whereas the maximum soil mean temperature is 32.8 °C in July and August. These temperatures were recorded at 5 cm depth(Abd El-Samie, 2000). Precipitation in Siwa Oasis is precarious and variable. The mean annual precipitation is about 9.5 mm. Evaporation rates ranges between 4.8 to 13.5mm/day, the lower values were recorded in December and the higher values were in June. Relative humidity varies from 30% in May and June to 56% in December, with a mean annual humidity of 41.2%. The effect of wind erosion is at its peak in April. Wind transports the loose particles of sand and salt and deposits them in topographic areas with lower contoursin the Oasis (Abdallah, 2007).

The Stratography of the exposed rocks in Siwa Oasis can be arranged from the oldest to the youngest as follow: Middle Eocene, upper Eocene, Oligocene, Miocene, recent and sub-recent deposits (Abu Al-lzz, 1971 and Said 1962). The Miocene deposits cover the greater part of the Oasis. They cover a large part of the depression floor, the entire northern scarp, and many hills of southern scarp such as Gabal El-Dakrur. The Miocene deposits are about 120 m in thickness and divided into lower unit of elastics and upper unit of solid limestone. The lower unit of elastics is widely distributed in the southern limits of the depression and it consists of shales, sandstones and marl beds that are rich in fossiliferous. Many of the shales are gypsiferous. The upper limestone unit is composed of coarse-grained limestone beds with some marl. The recent deposits are accumulated along the southern fringes of the depression, forming sanddunes in north-west direction and saline soils with surface crusts over large parts of the depression floor.

The geomorphologic features in Siwa depression include: the sea of sand, lakes, hills and mountains(Abu Al-Izz, 1971).The sea of sand occupies an area of about 500 km long by 160 to 180 km wide. The actual composition of this “sea” is waves of Seif dunes separated by wades. The most important lakes in Siwa depression are Al-Maraqui, Siwa, Khamisa, and Al-Zeitun lakes. This is in addition to a great number of small lakes. These lakes cover larger areas within the Oasis. The major hills in the Siwa are Urn Al-Huwaymil, QarefAl-Hamra, QarefAl-Bayda and Qaret El-Gari. The main mountains are Gabal El-Mawta (42m), Gabal Siwa (38m), Gabal El-Kosha (36m), GabalAghormi (16m), Gabal El-Dakrur (88m), Gabal El-Girba (120m), Gabal El-Migahiz (100m), Gabal western Migahiz (120m), and Gabal Umm Hiyus (90m).

Agriculture represents the main activity in the oasis. Currently, about 88 km^2 (20940 Feddans) of the Oasis are cultivated. This activity depends on the availability of groundwater from about 1199 wells and springs, which give a total annual discharge of about 255 million cubic meters (Samy, 2010).

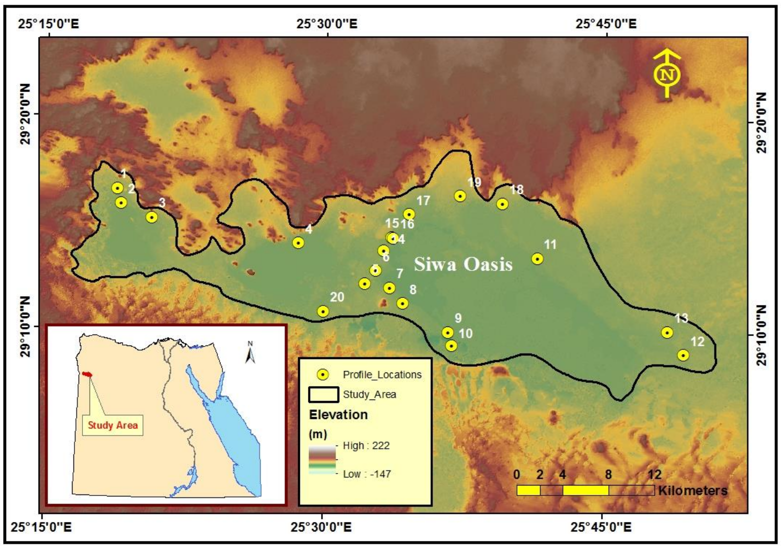

Fig.1. Study area in Siwa Oasis and locations of soil profiles.

Soil and water analyses:

Twenty geo-referenced soil profiles were dag throughout the studied area Fig. 1. and sampled based on their development. A total of 46 soil samples were collected from these profiles and analyzed for their physiochemical properties according to the methods described by the Soil Survey Staff (2010). Water samples were also collected from both irrigation wells and drainage canals. Chemical analyses of these water samples were carried out using the same methods.

Geostatistical analyses

Spatial distribution of the studied soils parameters was carried out using the ordinary Kriging under the geostatistical analyst extension in ArcGIS desktop software package (ver. 10.3).

Evaluation of Land capability and suitability

The Agriculture Land Evaluation System for arid and semi-arid regions (ASLEarid) developed by Ismail et al. (2012) was used in this work to evaluate land capability and suitability in Siwa Oasis. It works as an extension under ArcGIS software package. Several soil physical, chemical and fertility properties are integrated in this model. This is in addition to the quality of irrigation water, climatic conditions and environmental parameters. Many indices are calculated in this model including soil physical, chemical, fertility, water quality, and final soil capability index as well as the suitability classes for certain crops. The outputs are also displays in simple and handy maps that represent the spatial variability in each of the obtained indices and land suitability for certain crop all over the studied area.

RESULTS AND DISCUSSIONS

Variability within Soil Physical Properties

The ranges of soil physical properties within the studied area in Siwa Oasisare represented in Table 1. Total sand ranged between 55.25 and 98.03% with an average of 85.22%. Silt percentage varied from 0.02to 36.23% with an average of 8.14%. Clay percentage ranged between 1.34 and 22.40% with an average of 36.52%. Accordingly, the majority of soil textures in the studied area were Sandy. Saturation percentage ranged between 16.63 and 96.05% with an average of 38.37%. Organic matter was very low in the studied soils and ranged between 0.03 and 1.24% with an average of 0.41%. There was wide variability in calcium carbonate within the studied areadepending on soil parent material. Calcium carbonate varied from 1.71to99.66% with an average of 35.62%. Bulk Density ranged between 1.00 and 2.08 g cm^{-1} with an average 1.53 g cm^{-1}. Soil porosity ranged between 21.38 and 62.26% with an average 42.21%.

Table 1. Range, average and standard deviation (STD) of soil physical properties within the studied area in Siwa Oasis.

Property	Unit	Min.	Max.	Average	STD
Total Sand	(%)	55.25	98.03	85.22	9.58
Silt	(%)	0.02	36.23	8.14	8.65
Clay	(%)	1.34	22.4	6.64	5.15
Soil Texture		--	--	Loamy Sand	--
Saturation Percentage	(%)	16.63	96.05	38.37	18.37
Organic Matter	(%)	0.03	1.24	0.41	0.35
$CaCO_3$	(%)	1.71	99.66	35.62	28.98
Bulk Density	(gcm^{-3})	1.00	2.08	1.53	0.27
Porosity	(%)	21.38	62.26	42.21	10.35

Variability within Soil Chemical Properties

Data in Table2 represent the ranges of soil chemical properties within the studied area.Sodium was the prevalent cation in the studied soils and this was followed by calcium and magnesium. Sodium ions ranged between 0.51 and 102.77meq/100 g soil with an average 17.01meq/100 g soil. Calcium ranged between 0.55 and 15.51meq/100 g soil with an average 3.24meq/100 g soil. Magnesium ranged between 0.15 and 18.48meq/100 g soil with an average 3.50meq/100 g soil. On the other hand, Potassium had the lowest concentrations and it ranged between 0.04 and 1.26meq/100 g soil with an average 0.23meq/100 g soil.

Chlorides were the dominant anions in the studied soils and this was followed by sulfates. Chloride ranged between 0.86 and 110.76meq/100 g soil with an average 19.03meq/100 g soil. Sulphates ranged between 0.11 and 23.37meq/100 g soil with an average 4.24meq/100 g soil. Bicarbonates ranged between 0.12 and 3.54meq/100 g soil with an average 0.70meq/100 g soil. Soils in this oasis were moderately alkaline (soil pH ranged between 8.10 and 8.97 with an average of 8.41). The majority of soils in the Oasis were highly salinity, where the EC values varied from 4.25 to 427.17 dSm^{-1} with an average value of 76.76 dS m^{-1}.

It was noticed that magnesium was the dominant cation on the exchange complex, which could be attributed to the development of most of the soils in the Oasis on paleo lacks (Lacustrine deposits) or proximity of soils for current lakes. Exchangeable magnesium varied from 1.71 to 23.65 meq/100 g soil with an average of 11.76 meq/100 g soil. This was followed by calcium and sodium, respectively. The average values of exchangeable calcium and sodium were 9.07 and 3.71 meq/100 g soil, respectively.

Cation exchange capacity (CEC) varied from 9.84 to 40.50 meq/ 100 g (about 25.47meq/ 100 g soil in average). The higher values were associated with fine-textured soils, whereas the lower values were associated with the coarse-textured soils. Exchangeable sodium percentage (ESP) varied from 2.56 to 34.46%with an average of 14.62%. This indicates that the majority of the studied soils in the oasis were non-sodic soils.

Table 2. Ranges of soil chemical properties within the studied area.

Property		Min.	Max.	Average	STD
	Na^+	0.51	102.77	17.01	25.97
Soluble cations	K^+	0.04	1.26	0.23	0.24
(meq/100 g soil)	Ca^{2+}	0.55	15.51	3.24	2.83
	Mg^{2+}	0.15	18.48	3.5	3.91
	$CO3^{2-}$	0.00	0.00	0.00	0.00
Soluble anions	$HCO3^-$	0.12	3.54	0.70	0.81
(meq/100 g soil)	Cl^-	0.86	110.67	19.03	26.46
	$SO4^{2-}$	0.11	23.37	4.24	4.99
pH		8.10	8.97	8.41	0.23
EC (dSm^{-1})		4.25	427.17	76.76	113.39
	Ca^{2+}	2.18	20.83	9.07	4.46
Exchangeable Cations	Mg^{2+}	1.71	23.65	11.76	5.67
(meq/100 g soil)	Na^+	0.64	10.7	3.71	2.93
	K^+	0.27	3.17	0.92	0.66
CEC (meq/100 g soil)		9.84	40.5	25.47	8.61
ESP (%)		2.56	38.46	14.62	9.88

Variability within Soil Fertility Properties

Data in Table 3 show the ranges of available NPK, total nitrogen, organic carbon and C/N ratio in the studied soils. Available nitrogen (sum of $NH4^+$ and NO_3^-) ranged between 42.55 and 187.26 ppm with an average of 62.00 ppm. Available phosphorus ranged between 0.67 and 46.48 ppm, with an average 11.63 ppm. Available potassium ranged between 45.89 and 2316.22 ppm, with an average 518.35 ppm. Total nitrogen ranged between 0.01 and 0.21% with an average 0.07%, which is very low. Organic carbon ranged between 0.00 and 0.72% with an average 0.24%, which is very low. The C/N ratio ranged between 0.00 and 22.85%, with an average 3.99%.

Table 3. Ranges of available NPK, total nitrogen, organic carbon and C/N ratio in the studied soils.

Property	Unit	Min.	Max.	Average	STD
NH_4^+	(ppm)	14.73	104.03	36.79	18.00
NO_3^-	(ppm)	1.07	83.23	25.21	16.26
Av-N	(ppm)	24.55	187.26	62.00	33.65
Av-P	(ppm)	0.76	46.48	11.63	8.58
Av-K	(ppm)	46	2316	518	459
TN	(%)	0.01	0.21	0.07	0.04
OC	(%)	0.00	0.72	0.24	0.21
C/N Ratio	(%)	0.00	22.85	3.99	3.95

Variability within chemical Properties of Collected Water Samples

Spatial differences were found in water qualities among the collected water samples from Siwa Oasis. Sodium was the dominant cation in water samples as represented in Table 4. This was followed by magnesium and calcium, respectively. The average concentrations of cations in the collected water samples were for 0.66, 8.91, 9.07, and 19.01 meq l^{-1} for K, Ca, Mg, and Na; respectively. On the other hand, chlorides were the dominant anions followed by sulfates and bicarbonates, respectively. Their average concentrations were 2.08, 12.19, and 23.39 meq l^{-1} for HCO_{3-}, SO_4^{2-}, and Cl^-; respectively. Water pH varied from 7.91 to 8.27 (8.08 in average). EC values ranged between 2.28 to 5.45 dS m^{-1} (3.76 in average). This is because water samples were collected from the private well, which usually have a shallower depth (about 100 to 150 m) than the governmental wells (> 1000 m). Sodium adsorption ratio (SAR) varied from 4.34 to 8.09 (6.25 in average). Also, the residual sodium carbonates (RSC) had negative values (-19.91 meq l^{-1} in average). This is mainly due to the dominancy of calcium and magnesium ions in water samples, which reveals little possibility of soil conversion into sodic soils when irrigated with this water. The obtained results agree with those derived by Aly et al. (2016). They reported that the quality of groundwater in Siwa Oasis is deteriorating in alarming rate over time.

Table 4. Chemical analysis of collected groundwater samples from Siwa Oasis.

Property		Min.	Max.	Average	STD
	Na^+	11.69	28.70	19.01	7.17
Soluble cations	K^+	0.42	1.00	0.66	0.21
(meq/100 g soil)	Ca^{2+}	5.80	12.96	8.91	2.64
	Mg^{2+}	4.65	12.24	9.07	3.05
	$CO3^{2-}$	0.00	0.00	0.00	0.00
Soluble anions	$HCO3^-$	1.12	3.08	2.08	0.90
(meq/100 g soil)	Cl^-	14.50	35.90	23.39	8.50
	$SO4^{2-}$	7.21	17.53	12.19	4.04
pH		7.91	8.27	8.08	0.16
EC (dSm^{-1})		2.28	5.45	3.76	1.24
SAR		4.34	8.09	6.25	1.51
RSC (meq l^{-1})		-24.08	-9.33	-15.91	5.45

Land Capability indices

Soil index

Eleven soil parameters (clay content, available water (AW), hydraulic conductivity (Ks), soil depth (SD), groundwater depth, pH, total carbonates, gypsum, exchangeable sodium percentage (ESP), cation exchange capacity (CEC), and electrical conductivity (EC) were used in evaluating soils within the studied area. Based on these properties it was found that soils in the studied area were set only in two classes (fair (C3) and poor (C4)) as represented in Table 5 and Fig. 2. Soils in the fair class represented about 25.53%% of the studied area, whereas soils in the poor class represented the majority of the area (about 74.47% of the area).

Fertility index

Four fertility parameters (organic matter (OM) and available NPK) were used in evaluating soil fertility index in Siwa Oasis. It was found that soils in the studied area were located in three fertility classes, which are fair (C3), poor (C4) and very poor (C5) as represented in Table 5 and Fig. 3. Fair soils represented only about 4.04% of the studied area, whereas poor and very poor soils represented about 90.78 and 5.18% of the studied area, respectively.

Water index

Water quality index of irrigation water in the studied area was evaluated using four water chemical parameters (sodium (Na^+), chloride (Cl^-), sodium adsorption ratio (SAR), and electrical conductivity (EC). It was found that irrigation water in the studied area was good (S2) in its quality as shown in Table 5.

Final Land Capability Index

The above mentioned indices (soil, fertility and water indices) were used in evaluating the final land capability index for the studied soils. Soils in the studied area were set in two capability classes, which are Fair (C3) and Poor (C4) as represented in Table 5 and Fig. 4. Fair soils represented about 69.51% of the studied area, whereas poor soils represented about 30.49%.

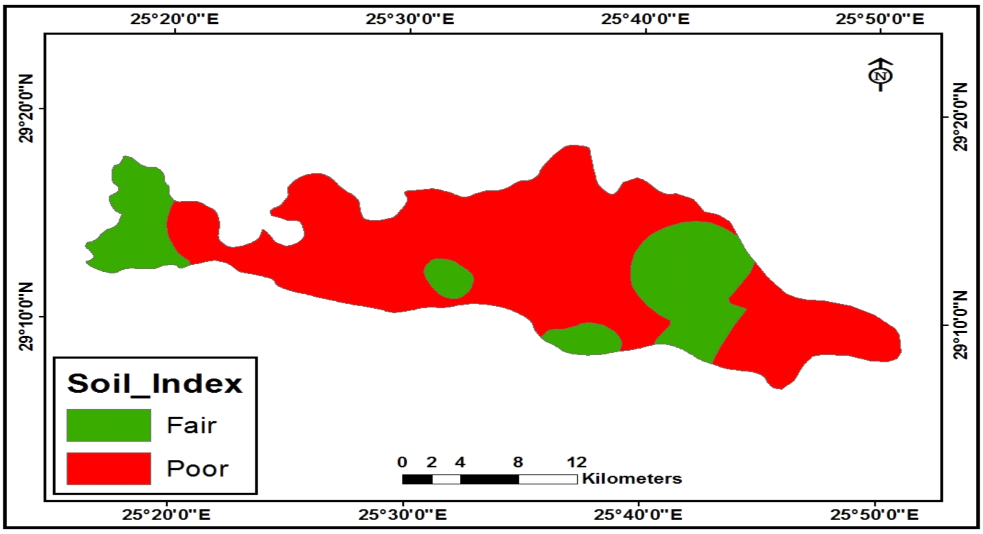

Fig. 2. Soil index of the studied soils in Siwa Oasis.

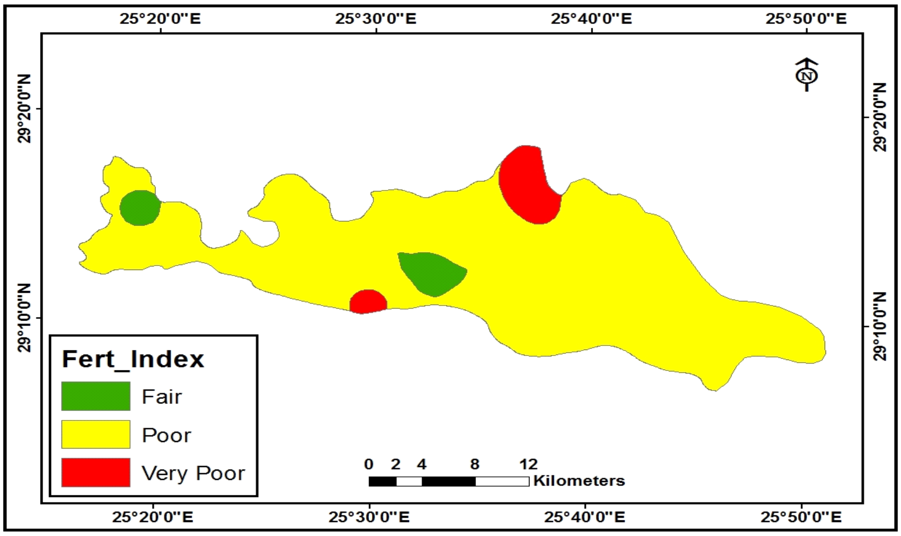

Fig. 3. Soil fertility index of the studied soils in Siwa Oasis.

Table 5. Soil capability indices of the studied soils profiles in Siwa Oasis.

Prof. No	Soil Index	Soil Class	Fert. Index	Fert. Class	IW Index	IW Class	LandCap. Index	LandCap. Class
1	39.32	C4	18.55	C5	69.47	S2	37.01	C4
2	48.72	C3	49.63	C3	69.47	S2	55.18	C3
3	35.86	C4	39.85	C4	69.47	S2	46.31	C3
4	27.06	C4	36.65	C4	69.47	S2	40.99	C3
5	55.37	C3	39.56	C4	69.47	S2	53.39	C3
6	30.67	C4	53.68	C3	69.47	S2	48.54	C3
7	34.35	C4	46.47	C3	69.47	S2	48.04	C3
8	27.3	C4	27.18	C4	69.47	S2	37.22	C4
9	38.55	C4	24.56	C4	69.47	S2	40.36	C3
10	42.82	C3	20.59	C4	69.47	S2	39.42	C4
11	46.68	C3	23.96	C4	69.47	S2	42.67	C3
12	36.33	C4	26.74	C4	69.47	S2	40.71	C3
13	36.11	C4	38.05	C4	69.47	S2	45.7	C3
14	25.84	C4	25.35	C4	69.47	S2	35.7	C4
15	27.17	C4	23.85	C4	69.47	S2	35.57	C4
16	33.59	C4	26.44	C4	69.47	S2	39.52	C4
17	41.65	C3	23.35	C4	69.47	S2	40.73	C3
18	26.72	C4	20.67	C4	69.47	S2	33.73	C4
19	24.93	C4	16.08	C5	69.47	S2	30.31	C4
20	28.67	C4	14.15	C5	69.47	S2	30.44	C4

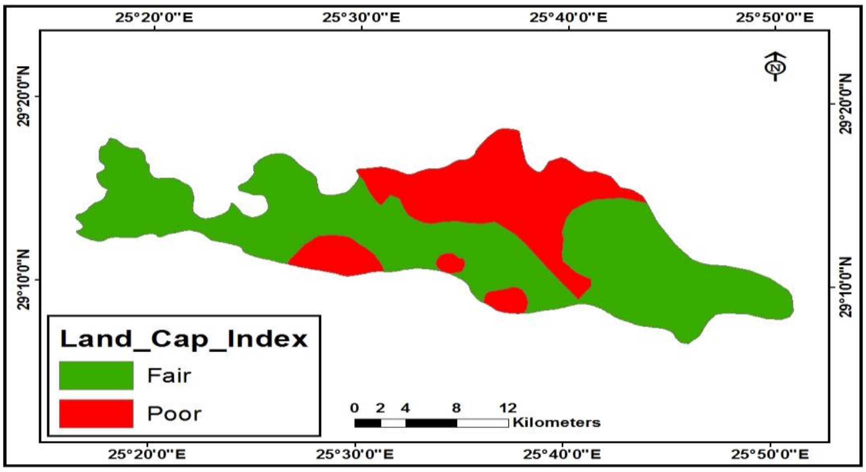

Fig. 4. Final land capability index of the studied soils in Siwa Oasis.

Land suitability classification

The suitability of the studied soils was evaluated for certain field crops, vegetables and fruit trees using ASLEarid model. Soil suitability was assessed for 18 common crops, which were classified into three categories as follows:

1. Field crops (wheat, barley, maize, sugar beet, faba bean, peanut, and alfalfa).

2. Vegetable crops (tomato, potato, pepper, onion, pea, and watermelon)

3. Fruit trees (date palm, olive, fig, grape, and citrus).

It is good to mention that the lake areas represented about 100 km^2 (about 19.21%) of the studied area in Siwa Oasis. Accordingly the rest of the area was about 421 km^2 (80.79% of the area). These areas were extracted from the Landsat 8 data acquired in August, 2015. Table 6 represents the studied field crops and the percentage of areas allocated for each suitability class. It could be observed that the majority of the studied area (> 73% of the area) was marginally suitable for wheat, barley, Sugar beet, and faba bean. On the other hand, about 24 to 29% of the area was moderately suitable for alfalfa and maize, whereas more than 50% of the area was marginally suitable for both of them. The studied area was equally divided between moderately and marginally suitable for Peanut. For the studied vegetable crops, the majority of the area was moderately suitable for tomato (75% of the area), whereas it was marginally suitable for pea and onion (75 to 78% of the area, respectively). Moderately suitable areas represented about 16% for potato and 34% for pepper, whereas marginally suitable areas represented about 65% for potato and 47% for pepper. Similar to peanut, the studied area was equally divided between moderately and marginally suitable for watermelon.

Soil suitability for the studied fruit trees was varied from suitable to permanently unsuitable, however suitable areas don’t represent more than 2% of the area in most cases. Moderately suitable areas represented about 4, 6, 10 and 19 10% of the area for olive, fig, date palm, and grape, respectively. About 22% of the area was marginally suitable for olive, fig, and date palm grape, whereas 54% was marginally suitable for grape. Currently unsuitable areas represented about 6% for citrus, about 16% for date palm, and about 18% for fig and olive. Permanently unsuitable areas represented about 32% for date palm, 34% for fig, and 37% for olive. The majority of the area (73%) was permanently unsuitable for citrus. Limitations for growing fruit trees in the studied area were mainly associated with soil salinity, soil depth, and poor drainage. The spatial distribution of land suitability for some of the studied crops was represented using the ArcGIS software as illustrated in Figs. 5 to 7.

Table 6: Land suitability for the selected field crops in Siwa Oasis.

No	Crop	S1	S2	S3	S4	N1	N2
1	Wheat	--	--	1.15	79.24	0.40	--
2	Barley	--	--	0.69	79.58	0.52	--
3	Maize	--	--	28.73	51.39	0.68	--
4	Sugar beet	--	--	0.97	76.62	3.21	--
5	Faba bean	--	--	1.30	73.01	6.48	--
6	Peanut	--	--	40.78	40.01	--	--
7	Alfalfa	--	--	24.14	56.65	--	--
8	Tomato	--	2.47	74.69	3.64	--	--
9	Potato	--	--	15.97	64.82	--	--
10	Pepper	--	--	34.04	46.75	--	--
11	Onion	--	--	--	78.07	2.72	--
12	Pea	--	--	4.01	75.34	1.44	--
13	Watermelon	--	--	40.05	40.75	--	--
14	Date Palm	--	1.91	9.85	21.55	15.81	31.68
15	Olive	--	0.28	3.85	21.90	18.18	36.58
16	Fig	--	1.04	5.99	22.33	17.49	33.94
17	Grape	--	0.41	18.83	54.01	3.69	3.85
18	Citrus	--	--	--	2.07	5.92	72.80

Where: S1= Very suitable, S2= Suitable, S3= moderately suitable, S4= marginally suitable, N1= currently unsuitable, and N2= permanently unsuitable.

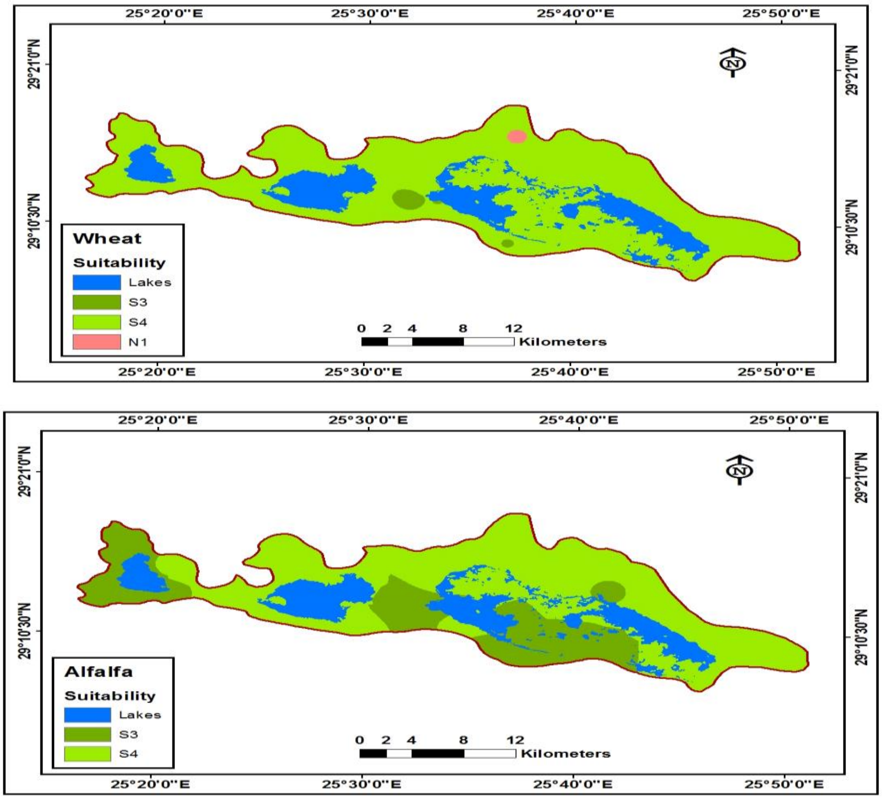

Fig. 5. Land suitability maps for wheat and alfalfa in Siwa Oasis.

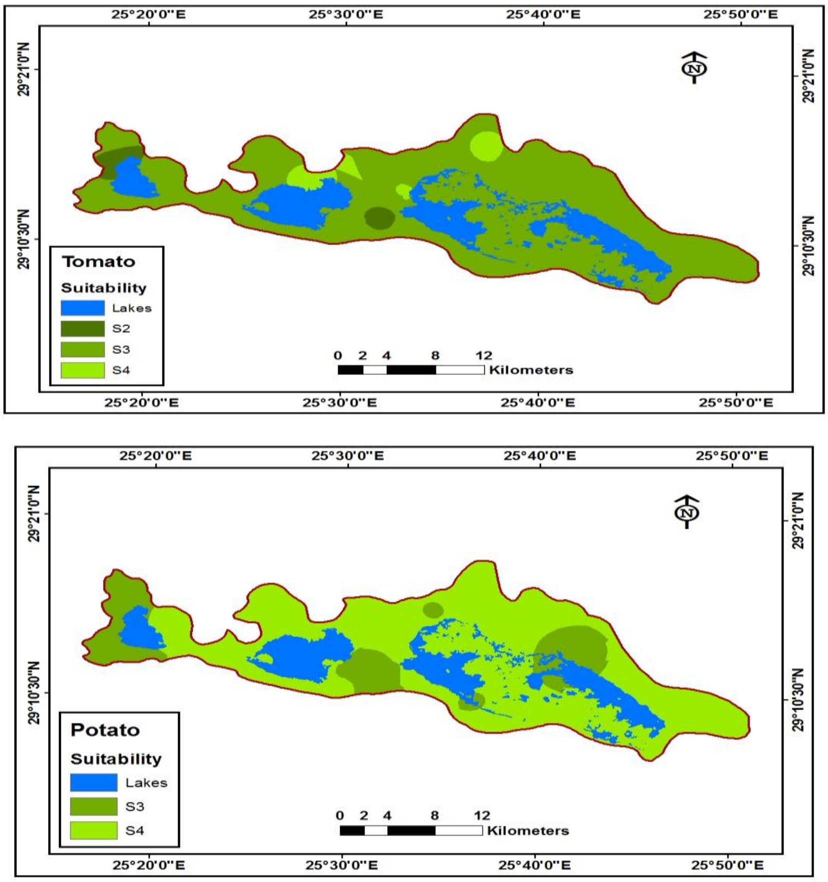

Fig. 6. Land suitability maps for tomato and potato in Siwa Oasis.

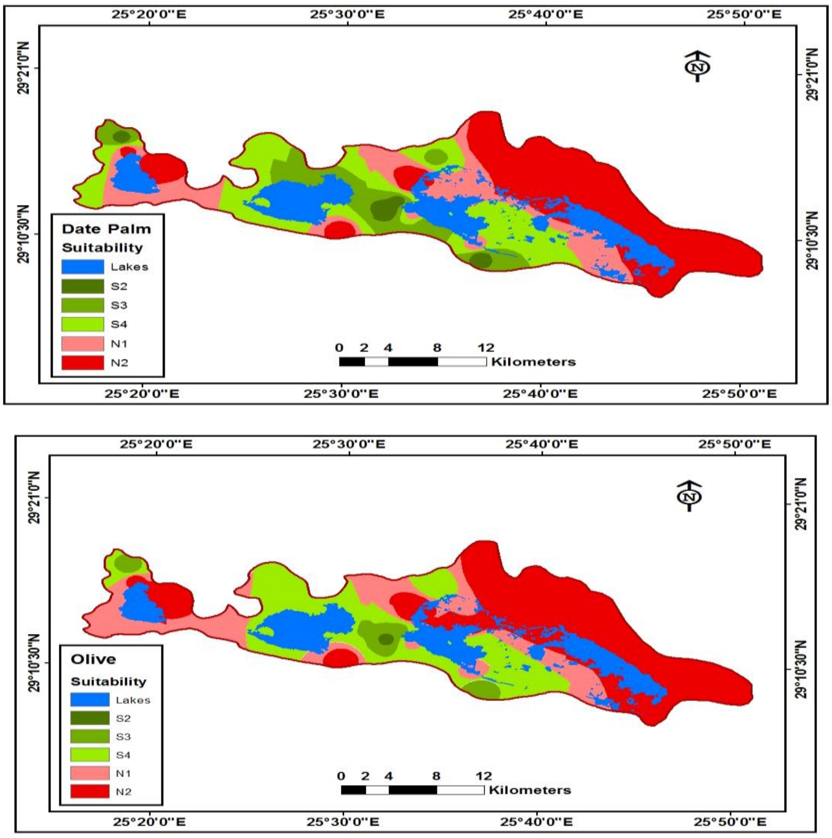

Fig. (7). Land suitability maps for date palm and olive in Siwa Oasis.

CONCLUSION

Land capability and suitability in Siwa Oasis were effectively evaluated using the Agriculture Land Evaluation System for arid and semi-arid region (ASLEarid). Soils in the studied area were fit into two capability classes. These classes are fair and poor. The fair class represented about 70% of the studied area. Poor land capabilities were mainly associated with high soil salinity, coarse texture and low fertility.

On the other hand, land suitability for the selected field crops and vegetables ranged between suitable to currently unsuitable. However, suitability for fruit trees varied from suitable to permanently unsuitable. Unsuitable areas for fruit trees were mainly associated with shallow soil depth, poor drainage and high soil salinity. Most of these limitations for plant cultivation can be eliminated through the proper land management practices.

In summary, soils in Siwa Oasis could have a promising future for agricultural reclamation and cultivation projects, where most of soil limitations for crop production in are none permanent and can be improved through implementing proper management practices.

REFERENCES

Abd El-Samie, M. K. K. (2000). Classification and evaluation of Siwa Oasis soils. PhD Thesis, Soil Sci. Dept, Fac. of Agric., Ain Shams Univ., Egypt.

Abdallah, A. (2007). Assessment of salt weathering in Siwa oasis, the western desert of Egypt. MSc Thesis, Department of Geography, Faculty of Arts, Benha University, Egypt.

Abu Al-Izz, M. S. (1971). Land Forms of Egypt. The Amer. Univ., Cairo press, 282, Egypt.

Aly, A. A.; Kishk, F. M.; Gaber, H. M. and Al-Omran, A. M. (2016). Long-term detection and hydrochemistry of groundwater resources in Egypt: case study of Siwa oasis. Journal of the Saudi Society of Agricultural Sciences, 15: 67–74.

Baniya, N. (2008). Land suitability evaluation using GIS for vegetable crops in kathmandu valley/Nepal. PhD Thesis, Institute of Horticultural Science, Faculty of Agriculture and Horticulture, Humboldt University, Berlin Germany.

Darwish, K. M.; Wahba, M. M. and Awad, F. (2006). Agricultural soil suitability of haplo-soils for some crops in newly reclaimed areas of Egypt. Journal of applied Sciences Research, 2(12): 1235-1243.

Dengiz, O. and Sağlam, M. (2012). Determination of land productivity index based on parametric approach using GIS technique. Eurasian Journal of Soil Science, 1: 51- 57.

Digby Wells Environmental (2015). Soils, land capability and land use. Environmental impact assessment for the De Groote Boom Project. Project report, Project Code UAR2967.

FAO, (2007). "Land Evaluation, towards a revised framework" land and water discussion paper No. 6, Rome, Italy.

Ganzorig, D. A. (1995). A knowledge-based approach for land evaluation using RS and GIS techniques. 16th Asian Conference on Remote Sensing was held on November 20-24, Thailand.

Ismail, M.; Abdel Ghaffar, M. K. and Azzam, M. A. (2012). GIS application to identify the potential for certain irrigated agriculture uses on some soils in Western Desert, Egypt. The Egyptian J. of Remote Sensing and Space Sciences 15, 39–51.

Khalifa, M. E. A. (2008). Assessment of soil mapping accuracy using RS, geostatistics and GIS traditional method case study. J. Agric. and Env. Sci. Alex. Univ., Egypt, 7 (2): 158-176.

Rasheed, M. A.; Gad, A.; Moeller. R. Z. and Darwish, K. M. (2008). Geographic mapping and analysis using GIS of study areas in Bahariya Oasis, Egypt. American-Eurasian J. Agric. and Environ. Sci., 4 (1): 125-130.

Rossiter, D. G. (1996). A theoretical framework for land evaluation. Geoderma, 72: 165-202.

Said, R. (1962). The Geology of Egypt. Elsevier Publication Company, Amsterdam, New York.

Samy, A. R. (2010). A Desertification impact on Siwa Oasis: present and future challenges. Res. J. Agric. and Biol. Sci., 6(6): 791-805.

Soil Survey Staff (2010). Keys to Soil Taxonomy. 11th edition, Natural Resources Conservation Service, USDA, USA.

Sys, C.; E. VanRanst and J. Debaveye (1991). " Principle of Land Evaluation". Agriculture publication. ITC Belgium.

تقييم القدرة الإنتاجية الزراعية للأرض باستخدام تقنيات الاستشعار عن بعد ونظم المعلومات الجغرافية في واحة سيوه ، مصر

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تمثل واحة سيوة واحدة من أهم المنخفضات في الصحراء الغربية في مصر. وتأتي هذه الأهمية من توافر الموارد المائية والتي يمكن استخدامها في مشاريع استصلاح وزراعة الأراضي. وتبعا لذلك، كان الهدف الرئيسي من هذا العمل هو تقييم الإنتاجية الزراعية للتربة في واحة سيوة. ولهذا الغرض تم حفر 20 قطاع أرضى معلومة الأحداثيات وأخذ عينات منها بناء على درجة تطورها. حيث تم جمع عدد 46 عينة تربة من هذه القطاعات وتحليلها للتعرف على خصائصها الفيزيائية والكيميائية . كما تم أيضا جمع عينات مياه من آبار الري وقنوات الصرف. وقد تم تحليل هذه العينات للتعرف على خصائصها الكيميائية. وأجري تقييم الأراضي باستخدام نظام تقييم الأراضى الزراعة فى المناطق الجافة وشبه الجافة (ASLEarid). وقد دلت النتائج على أن الأراضى في واحة سيوة تقع فى فئتين (معتدلة وفقيره) على أساس مؤشر التربة. بينما تقع في ثلاث فئات (معتدلة وفقيره وفقيره جدا) على أساس مؤشر خصوبة التربة. وكانت نوعية المياه جيدة لري المحاصيل. وكانت القدرة الأنتاجية للأراضي معتدلة وفقيره. وتمثل التربة المعتدلة حوالي 70٪ من منطقة الدراسة والتربة الفقيرة تمثل بقية المنطقة. ويرجع سوء خواص التربة أساسا إلى ارتفاع ملوحة التربة وخشونة القوم وانخفاض الخصوبة وسوء الصرف. ومع ذلك، فإن هذه المشاكل يمكن التغلب عليها من خلال الإدارة السليمة واجراء عمليات الغسيل واستخدام طرق الرى الحديثة وأضافة المخصبات للتربة. وتم أيضا تقييم مدى ملائمة التربة في واحة سيوة لعدد 18 محصول. وتراوحت ملائمة التربة لهذه المحاصيل بين ملائمة وغير ملائمة بشكل دائم.