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(Original Article)

Soil Suitability Assessment for Twenty Crops in East Edfu Soils, Aswan

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Abstract

Soil suitability assessment is critical for sustainable land use planning. The area east of Edfu in Aswan governorate is important for agriculture production. Therefore, this study aimed to determine, assess, and map the soil suitability for growing selected twenty crops in the study area using the ASLE program. Twenty sampling sites in east Edfu representing an area of 7166.52 ha were chosen for the current study. All sampled site coordinates were recorded using (GPS) and then plotted on a map using ArcGIS. Soil samples were collected from each site at a depth of 0–60 cm. Moreover, the soil physical and chemical characteristics (e.g., soil texture, soil depth, $CaCO_3$, ECe and ESP) that are substantially related to the potential land use and their limitations were determined. Furthermore, the spatial distribution maps of soil suitability of all the selected crops were produced employing ArcGIS software. The results revealed that soils under study are characterized by a coarse texture, as the dominant texture classes were loamy sand and sandy loam. Concerning the soil depth, the soils of the investigated sites have a moderate limitation for agricultural land use. The lime content is less than 10% in most of the studied soil sites. Most of these soils have slight to moderate limitations for salinity. For soil sodicity (ESP), about 90 % of the total study area has an ESP value that is less than 15%. The results are also revealed, sunflower, watermelon, pepper, sorghum, maize, sugarbeet, potato, tomato, are suitable and moderately suitable crops for these soils.

Keywords: *Soil suitability, Soil proprieties, Aswan, Land use planning*

Introduction

Soil is one of the most important natural resources of a country and knowledge about its characteristics is essential for developing optimum land use plan for maximizing agricultural production. So, study of situation of soil characteristics for cultivation of different crops in very importance. Land suitability evaluation is an examination process of the degree of land suitability for a specific utilization type and/or description method or estimation of potential land productivity (Sys *et al*., 1991). Evaluating agricultural land management practices requires knowledge of soil spatial variability and understanding their relationships (Jenny, 1980; Quine and Zahng, 2002). Hence, an understanding of the distributions of soil properties at the field scale is important for refining

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agricultural management practices and assessing the effects of agriculture on environmental quality (Cambardella *et al*., 1994). Variability can also occur as a result of land use and management strategies, making the soil to exhibit marked spatial variability at the macro– and micro– scale (Brejda *et al*., 2000; Vieira and Paz-Gonzalez, 2003). Soil properties vary spatially and temporally from a field to a larger region scale and are influenced by both intrinsic (soil formation factors, such as soil parent materials) and extrinsic factors (soil management practices, fertilization and crop rotation) (Cambardella and Karlen, 1999).

Ismail *et al.* (2001) developed applied system for land evaluation (ASLE) in arid and semi-arid regions. They identified four major factors to define land capability classes: soil physicochemical properties, environmental status, irrigation system, water quality, and soil fertility. This developed method (ASLE) also included soil suitability classification for a variety of crops. Many researches have reported positive effects of applying ASLE program system (Zamil *et al.,* 2009) conducted a quantified land evaluation study in the governorate of Kafr El Sheikh in the northern Delta. In that study ASLE program was used for calculating land capability and soil suitability for different crops. They indicated that the limiting factors for land use in agriculture were the relatively low soil permeability, the shallow ground-water table in some parts, the relative increment of soil salinity in others, as well as ground-water salinity, low levels of soil organic matter, and nutrients, especially NPK. Different crops can be grown in these soils, except pepper, olive, fig, and peanut. According to Abd El-Azem (2020), the applied system of land evaluation (ASLE) program for arid and semiarid regions was used to determine the suitability for growing twenty-eight field crops, forage, vegetables and fruit trees, the most suitable crops to be grown in the study area are in the order of: date palm, sunflower sugar beet, fig, olive, tomato, barley, wheat, cotton, sugar can, alfalfa, sorghum, cabbage, rice, maize, grape, peanut, watermelon, potato, onion, pepper, fababeen, apple, citrus, pear, banana, pea, and soybean.

Aswan governorate, located between latitudes 22° 45' and 25° 15' N and longitudes 32° 30' and 34° 40' E, is an important zone for agricultural expansion. It is estimated to be 62,726 km^2 with a population density of less than 2%.

Based on the above, then we can see that soil suitability assessment is critical for long-term land use planning, and helps to build databases for the investigated soils, which significantly helps the decision makers and contributes to better investment process. Therefore, the current study aims to assess and map the soil suitability classes for growing the selected twenty crops in some soils in the east Edfu area using the ASLE program.

Materials and Methods

Aswan Governorate is located in the arid zone of southern Egypt. The climatic conditions of this area are characterized by a hot and dry summer with scanty winter rainfall and bright sunshine all the year. Edfu is one of the cities in Aswan Governorate, and the study area is located in the east part of the city. The study area in East Edfu is estimated to be 7166.52 hectares. Furthermore, the study area is located between latitudes 24°54' and 25° 0' N, and longitudes 32°57' and 32°58' E. The average mean annual temperature is 27.53°C with great difference between summer and winter. The maximum temperature (41.66°C) was recorded in August while the minimum temperature (10.15°C) was recorded in January. The lowest wind velocities recorded at Aswan in January was 18.24 km/hr, and highest velocities recorded was in December 34.84 km/hr, the annual mean of surface wind velocity was 22.03 km/hr. The relative humidity has a monthly mean value of 15.39 % recorded in May, and 40.87 % recorded in December and; the mean annual humidity in Aswan is 24.98 % (Egyptian Metrological Authority) as shown in Figure 1.

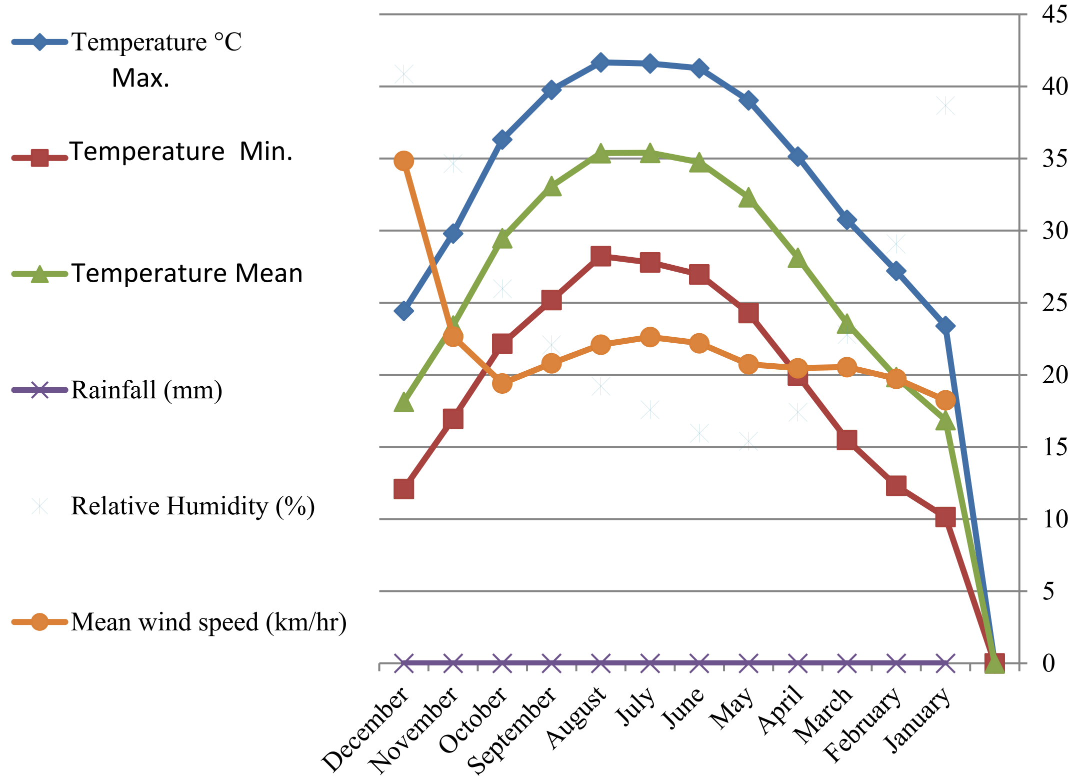


Fig.1. Chart of climatic data of the Aswan Governorate between 2009 to 2019

Table 1. Laboratory methods used for determining soil physicochemical attributes

Soil property	Method	Reference
Saturation percentage (SP)	Volumetric method	(Hesse, 1998)
Mechanical analysis	Pipette method	(Piper, 1947)
Hydraulic conductivity	Constant head system	(Richards, 1954).
Bulk density	Graduated cylinder method	(Bodman, 1946)
Particle density	The pycnometer method	(Blake and Hartge, 1986).
Soil pH	Using a glass electrode (pH-Meter)	(Jackson, 1973).
Electrical conductivity (EC)	EC-Meter	(Jackson, 1973).
Calcium carbonate ($CaCO_3$)	Scheibler Calcimeter method	(Jackson, 1967).
Cation exchange capacity (CEC)	Sodium acetate method	(Jackson, 1973).
Organic matter (O.M)	Dichromate oxidation method	(Walkely and Black's, 1954) (Jackson, 1973).

All sampled site coordinates were recorded using the global position system

device (Garmin GPS) and then plotted on a map using ArcGIS (Figure 2). Soil samples were collected from twenty sites in east Edfu under different cropping patterns as shown in Figure 1. Soil samples were collected from each site at a depth of 0–60 cm using an auger and then transported to the laboratory. At the laboratory, soil samples were air-dried, crushed, and sieved through a 2 mm sieve and stored in plastic containers for soil physical and chemical analyses. They were then analyzed using the standard methods as shown in Table 1. Soil porosity was calculated according to Danielson and Sutherland (1986), while exchangeable sodium percentage (ESP) and sodium adsorption ratio (SAR) were computed according to Jackson (1967).

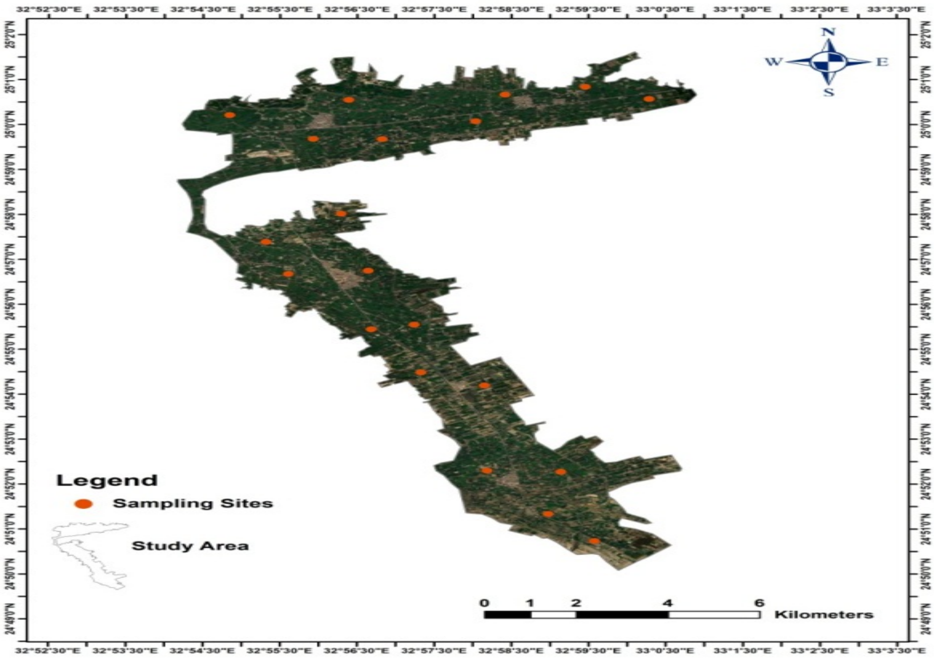


Fig. 2. Map of soil sampling sites in the study area

Table 2. Criteria for evaluation of soil texture limitations as suggested by Sys (1979)

Texture type	Limitation	General term	Texture class
Coarse	Severe	Coarse texture	Sand and loamy sand
		Moderate coarse texture	Sandy loam
Medium	Slight	Medium texture	Loam, silt loam and silt
Fine	Moderate	Moderately fine texture	Clay loam, sandy clay, loam and silt clay loam
		Fine texture	Sandy clay, silt clay and clay

Table 3. Criteria for evaluation of soil depth limitations as proposed by Sys (1979)

Soil depth (cm)	General term	Limitation	Rating (%)
0 – 50	Shallow	Severe	30 – 55
50 – 100	Moderately deep	Moderate	70 – 90
> 100	Deep	Slight	100

Table 4. Criteria for evaluation of soil lime limitations as suggested by Sys (1979)

Lime (%)	General term	Limitation	Rating (%)
0 – 10	Slightly calcareous	Moderate	85 – 90
10 – 25	Moderately calcareous	Slight	100
> 25	Strongly calcareous	Moderate	85 – 90

Table 5. Criteria for evaluation of soil salinity and sodicity limitations as proposed by Sys (1979)

Parameter		ECe (dS/m)		
		0 – 8	8 – 30	> 30
ESP (%)	Limitation	Slight	Moderate	Severe
0 – 15	**Slight**	90 – 100	70 – 90	50 – 80
15 – 30	**Moderate**	70 – 96	50 – 85	40 – 58
> 30	**Severe**	60 - 85	40 - 75	30 – 45

As shown in Tables 2, 3, 4, and 5, limitation factors of soil use in agricultural production such as texture, depth, lime, salinity, and sodicity were evaluated using the criteria suggested by Sys (1979). Soil suitability for the selected crops was assessed using the ASLE program developed by Ismail *et al.* (2001), using soil data such as texture, soil profile depth, $CaCO_3$ content, salinity, and alkalinity of the investigated soils, as well as climatic data of the study area. According to Ismail *et al*. (2001), soil suitability classes for different crops classify into six categories: highly suitable (S1), suitable (S2), moderately suitable (S3), marginally suitable (S4), currently not suitable (NS1), and permanently not suitable (NS2). Soil suitability class maps of the selected crops under the current study were created by employing ArcGIS software (Arc Map 10.8).

Table 6. Descriptive statistics of the weighted mean of the studied soil properties (*n* = 20)

Property	Range	Minimum	Maximum	Mean	SD	CV%
SP (%)	23.3	24.2	47.5	30.7	6.9	22.5
Clay (%)	31.5	4.5	36.0	10.2	6.6	64.7
Silt (%)	24.4	3.7	28.1	10.9	7.1	65.1
Sand (%)	34.0	55.1	89.1	79.0	9.4	11.9
H.C (cm/h)	41.2	0.3	41.5	11.1	11.5	103.6
PD (Mg/m^3)	0.2	2.6	2.7	2.7	0.0	0.0
BD (Mg/m^3)	0.3	1.2	1.5	1.4	0.1	7.1
Porosity (%)	9.4	44.6	53.9	47.4	2.3	4.9
pH (1:2.5)	0.8	7.5	8.3	7.8	0.2	2.6
ECe (dSm^{-1})	53.6	3.8	57.4	13.0	12.3	94.6
$CaCO_3$ (%)	11.9	0.7	12.6	4.6	3.0	65.2
CEC ($cmol^{(+)}/kg$)	39.3	12.8	52.1	23.8	11.2	47.1
ESP (%)	81.6	0.3	81.9	6.7	18.2	271.6
SAR	9.8	2.2	12.0	6.7	2.9	43.3
O.M (%)	1.3	1.3	2.6	1.9	0.4	21.1
Texture class			SL, SC, LS, S,			

n = number of soil samples; SD = standard deviation; CV = coefficient of variation; SP= saturation percent; H.C = Hydraulic conductivity; PD= Particle density; BD= Bulk density; EC = electrical conductivity; $CaCO_3$= Calcium carbonate; CEC= cation exchange capacity; ESP= exchangeable sodium percentage; SAR= Sodium adsorption ratio; OM = organic matter; soil texture grade: SL = sandy loam; SC = sandy clay; LS = loamy sand; S= sand.

Results and Discussion

Descriptive statistics for soil attributes

Descriptive statistics based on the weighted mean of the soil properties are as shown in Table 6. The range values of the studied soil characteristics vary from 0.2 to 81.6 among the soil sites, which indicate that some soil properties have very high difference between their minimum and maximum values such as SP, clay, silt, sand, hydraulic conductivity, ECe, $CaCO_3$, CEC, ESP and SAR. On the contrary, the range values of particle density, bulk density, porosity, pH, and OM indicated that their minimum and maximum values are close to each other.

The mean values of investigated characteristics varied from 1.4 to 79.0 among the soil sites. The high mean values (> 23.8) are found for CEC, SP, porosity and sand, while the low values (< 23.8) are recorded in the other studied properties. The standard deviation (SD) values ranged from 0.0 to 18.2 among the studied characteristics. A low standard deviation indicates that the data points tend to be close to the mean of the set such as bulk density, particle density, pH and OM, while a high standard deviation indicates that the data points are spread out over a wide range of values such as sand, CEC, hydraulic conductivity, ECe, and ESP.

The coefficient of variation (CV) differs from one variable to another and it varies from 0.0 to 271.6 %. It indicates that the variability is low for the particle density, pH, porosity, bulk density and sand (CV= 0.0- 2.6- 4.9- 7.1- 11.9%) respectively, moderate for OM and SP, and high to very high for the rest of properties. Ranking the coefficient of variation (CV) of soil properties into different classes including least (<15%), moderately (15% - 35%), and highly (>35) variable according to (Wilding, 1985). The highest variation is recorded in ESP which is easy to respond either negatively or positively to the agricultural management practices and climate conditions.

Coefficients of correlation among soil properties

Correlation coefficients showed that there was a positive or negative correlation at $p < 0.01$ and/or $p < 0.05$ (Table 7). The result indicated that the clay had high significant positive correlation with $CaCO_3$ (r= 0.607**), significant correlation with CEC (r= 0.553*). While it was a high significant negative correlation with sand (r= -0.655**), and PD (r= 0.625**). Additionally, there was a high significant positive correlation with silt and porosity (r= 0.700**), and with CEC (r= 0.567**). But there was a high significant negative correlation with sand (r= -0.713**), and with BD (r= -0.745**). The parameter of sand there was a high significant positive correlation with PD (r= 0.675**), and BD (0.631**), and significant positive correlation with HC (r= 0.555*), and with pH (r= 0.510*). While there was a high significant negative correlation with $CaCO_3$ (r= -0.751**), and with CEC (r= -0.817**).

Table 7. Correlation matrix among soil properties (n= 20)

Soil property	SP	Clay	Silt	Sand	H.C	PD	BD	Porosity	pH	ECe	$CaCO_3$	CEC)	ESP	SAR	OM
SP (%)	1														
Clay (%)	0.531*	1													
Silt (%)	0.705**	-0.062	1												
Sand (%)	-0.906**	-0.655**	-0.713**	1											
H.C (cm/h)	-0.326	-0.381	-0.380	0.555*	1										
PD (Mg/m^3)	-0.785**	-0.625**	-0.312	0.675**	0.096	1									
BD (Mg/m^3)	-0.653**	-0.096	-0.745**	0.631**	0.284	0.403	1								
Porosity (%)	0.401	-0.158	0.700**	-0.419	-0.274	-0.038	-0.928**	1							
pH (1:2.5)	-0.638**	-0.254	-0.438	0.510*	.024	0.633**	0.501*	-0.293	1						
ECe (dSm^{-01})	0.055	-0.168	0.294	-0.104	-0.274	0.030	0.202	-0.180	0.134	1					
$CaCO_3$ (%)	0.817**	.607**	0.429	-0.751**	-0.387	-0.656**	-0.526*	0.315	-0.525*	-0.196	1				
CEC ($cmol^{(+)}/kg$)	0.690**	0.553*	0.567**	-0.817**	-0.557*	-0.554*	-0.336	0.156	-0.268	0.554*	0.485*	1			
ESP (%)	0.032	-0.036	0.165	-0.100	-0.250	-0.042	0.228	-0.243	0.171	0.937**	-0.155	0.627**	1		
SAR	-0.052	-0.180	0.042	0.095	0.386	0.139	0.088	-0.024	0.04	0.386	-0.284	0.159	0.43	1	
OM (%)	0.199	-0.103	0.261	-0.125	-0.035	-0.102	-0.385	0.353	-0.244	-0.319	0.096	-0.084	-0.362	-0.203	1

Significant correlation at 0.05 level (2-tailed); ** Significant correlation at 0.01 level (2-tailed); *n* = number of soil samples; SP= saturation percent; H.C = Hydraulic conductivity; PD= Particle density; BD= Bulk density; EC = electrical conductivity; $CaCO_3$= Calcium carbonate; CEC= cation exchange capacity; ESP= exchangeable sodium percentage; SAR= Sodium adsorption ratio; OM = organic matter.

Additionally, there was significant negative correlation between HC and CEC (r= -0.557*). The particle density there was a high significant positive correlation with pH (r= 0.633**). But there was a high significant negative correlation with $CaCO_3$ (r= -0.656**), and significant negative correlation with CEC (r= -0.554*), as well as there was a high significant negative correlation between bulk density and porosity (r= -0.928**), and significant negative correlation with $CaCO_3$ (r= -0.526*). While it was significant positive correlation with pH (r= 0.521*). For the soil pH there was significant negative correlation with $CaCO_3$ (r= -0.525*).The parameter of ECe showed a high significant positive correlation with ESP (r= 0.937**), and there was significant positive correlation with CEC (r= 0.554*), as well as there was a high significant positive correlation between CEC and ESP (r= 0.627**), and there was significant positive correlation with $CaCO_3$ (r= 0.485*). These findings revealed that the selected parameters had interrelationships and were correlated with each other.

Factor limiting agricultural use of the studied soils

The physical and chemical characteristics (e.g., soil texture class, soil depth, CaCO3 content, ECe and ESP) that are substantially related to the potential land use and their limitations according to Sys (1979) based on their weighted mean values are presented in Table 8.

The assessment of limitation factors based on soil characteristics revealed that the soils of the study area have a severe limitation due to the soil texture property. This finding is because the studied soils are characterized by a coarse texture. The results indicated that the texture classes of the studied soils were loamy sand (55%), sandy loam (35%), sand (5%), and sandy clay (5%). Soil depth is considered one of the most limiting factors that restrict land use. Regarding the soil depth, the soils of the investigated sites have a moderate limitation for agricultural land use. This indicated that the studied soils have a suitable depth for agricultural use. Thus, about 100% of the study area based on depth weighted mean values had moderate limitation for soil depth (more than 50 cm depth).

Based on the lime evaluation rate suggested by Sys (1979) as shown in Table (4), the lime content that is less than 10% dominates in most of the study soil sites; about 90 % of studied soil sites have a moderate limitation. However, it is considered slight in some sites of the studied soils which the lime content is more than 10 %; it representative 10 % of studied soil sites. The saline or salt affected soils are common in the arid and semi-arid regions. The obtained results showed that the soils of the study area have slight to moderate limitations due to soil salinity except two sites (No. 9 and 15), which were severe (Table 8). For the soil sodicity (ESP), about 90 % of the total study area has an ESP value that is less than 15%, while the rest of 10 % have an ESP value that is more than 15%. So, most of the study area has slightly sodic limitations and some of it shows moderately to severely sodic ones. The salinity and sodicity are affected by poor quality of irrigation water and human activity. The main limiting factors of the studied soils for the agricultural use are the soil texture, calcium carbonate content, and soil salinity and sodicity.

Table 8. The limitations of the studied soil properties for agricultural use, according to Sys (1979)

Site No.	Depth (cm)	Soil Texture Grade	ECe (dSm^{-1})	$CaCO_3$ (%)	ESP (%)
	Limitation	Limitation	Limitation	Limitation	Limitation
1	Moderate	Severe	Slight	Slight	Slight
2	Moderate	Moderate	Slight	Slight	Slight
3	Moderate	Severe	Slight	Moderate	Slight
4	Moderate	Severe	Moderate	Moderate	Slight
5	Moderate	Severe	Moderate	Moderate	Slight
6	Moderate	Severe	Moderate	Moderate	Slight
7	Moderate	Severe	Moderate	Moderate	Slight
8	Moderate	Severe	Slight	Moderate	Slight
9	Moderate	Severe	Severe	Moderate	Moderate
10	Moderate	Severe	Moderate	Moderate	Slight
11	Moderate	Severe	Moderate	Moderate	Slight
12	Moderate	Severe	Moderate	Moderate	Slight
13	Moderate	Severe	Moderate	Moderate	Slight
14	Moderate	Severe	Moderate	Moderate	Slight
15	Moderate	Severe	Severe	Moderate	Severe
16	Moderate	Severe	Moderate	Moderate	Slight
17	Moderate	Severe	Moderate	Moderate	Slight
18	Moderate	Severe	Slight	Moderate	Slight
19	Moderate	Severe	Slight	Moderate	Slight
20	Moderate	Severe	Moderate	Moderate	Slight

Soil suitability assessment for growing the selected crops

Studied soils were evaluated to determine their suitability for growing the selected twenty using ASLE program. The soil parameters used for estimating suitability index for the different crops such as climate, texture, soil profile depth, calcium carbonate, salinity and alkalinity. Table 9 and Figures 3 to 7 showed the soil suitability classes for the selected crops. Results in Table 9 revealed that sunflower, watermelon, pepper, sorghum, maize, sugarbeet, potato, tomato, are suitable and moderately suitable crops for these soils with S2, S3 classes, followed by, barley, pea, cotton are considered marginally suitable (S4), Fababean, wheat, onion, soya bean, alfalfa, sugarcane, cabbage, peanut, rice, are considered unsuitable crops (NS1 and NS2) for all soils under study. The results of the current study indicate that the use of ASLE program is appropriate for the soil suitability evaluation for the agricultural proposes because of its compatibility to the Egyptian conditions. A brief discussion about the suitability of the studied soils for tested crops that may be grown in the investigated area according to given below

Table 9. Land suitability classes and their areas for the selected crops

Suitability class	Onion		Sugarcane		Peanut		Rice		Sunflower		Tomatoes		Sorghum		Watermelon		Pepper		Wheat	
	Area																			
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
S1	0.0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
S2	6.8	489.3	0	0.0	0	0.0	0	0.0	6.6	471.0	6.6	476.2	3.2	228.9	17.2	1232.7	14.8	1059.8	6.0	426.6
S3	3.3	233.2	1.1	78.8	0	0.0	0	0.0	43.6	3122.8	10.8	771.6	22.7	1625.8	17.0	1219.5	13.9	998.6	4.5	325.7
S4	2.6	188.4	0	0.0	0	0.0	0	0.0	17.0	1219.9	30.2	2161.0	30.8	2204.6	24.9	1787.9	33.5	2400.1	6.6	470.0
NS1	9.6	691.5	34.3	2454.9	94.9	6797.5	0.6	39.7	31.5	2254.0	32.0	2293.0	41.5	2973.7	33.6	2411.4	24.8	1775.4	76.8	5502.1
NS2	77.6	5564.0	64.7	4634.0	5.1	369.0	99.4	7126.9	1.4	98.8	20.4	1464.8	1.9	133.5	7.2	515.0	13.0	932.7	6.2	442.2
Total	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52
Suitability class	**Barley**		**Fababean**		**Cotton**		**Maize**		**Soyabean**		**Sugarbeet**		**Pea**		**Alfalfa**		**Cabbage**		**Potato**	
	Area																			
	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha
S1	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	1.5	108.6	0	0.0	0	0.0	0	0.0	0	0.0
S2	6.1	436.2	4.5	324.9	0	0.0	0	0.0	0	0.0	7.6	546.4	8.4	600.5	6.0	426.6	0	0.0	0	0.0
S3	4.6	326.2	4.3	308.2	7.3	521.8	21.4	1532.2	8.0	571.4	5.1	368.9	0	0.0	0	0.0	0	0.0	20.6	1477.7
S4	11.8	843.2	9.1	649.0	11.0	790.0	19.4	1392.1	0	0.0	38.7	2775.3	11.7	837.9	0	0.0	0	0.0	0	0.0
NS1	71.4	5118.6	42.5	3046.3	29.6	2120.0	48.4	3468.0	28.0	2007.1	40.7	2918.2	51.6	3696.8	59.0	4226.2	9.9	710.2	64.6	4629.5
NS2	6.2	442.2	39.6	2838.2	52.1	3734.6	10.8	774.1	64.0	4588.0	6.3	449.1	28.3	2031.3	35.1	2513.8	90.1	6456.4	14.8	1059.3
Total	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52	100	7166.52

S1= Highly suitable; S2= Suitable; S3= Moderately suitable; S4= Marginally suitable; NS1= Currently not suitable; NS2= Permanently not suitable

Sunflower

The current soil suitability of the investigated area for sunflower growth is shown in Table 9 and Figure 3a. The majority of the studied soils 3122.8 hectares, 43.6 % are moderately suitable (S3) and about 471.0 hectares, 6.6 % are suitable (S2), about 1219.9 hectares, 17 % are marginally suitable (4), and about 2254.0 hectares, 31.5 % are currently not suitable (NS1), about 98.8 hectares, 1.4 % are permanently not suitable (NS2).

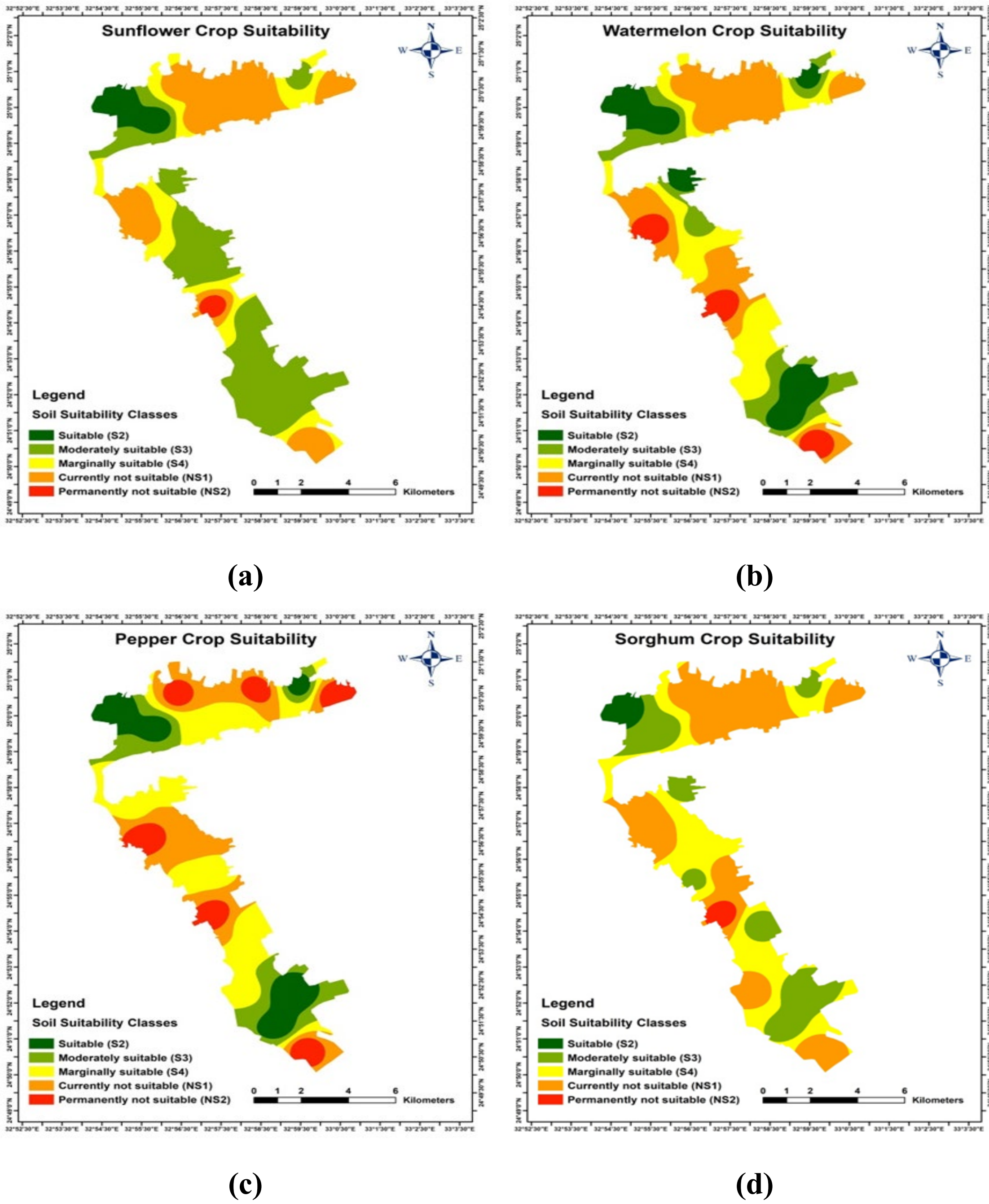


Figure 3. The distribution maps of soil suitability classes for selected crops: a) Sunflower, b) Watermelon, c) Pepper, and d) Sorghum.

Watermelon

The current suitability classes for growing watermelon in the study area are present in Table (9) and Figure (3b). Nearly, 1232.7 hectares (17.2% of the total area) are suitable (S2), 1219.5 hectares (17 %) are moderately suitable (S3) and 1787.9 hectares, (24.9%) are marginally suitable (4), Nevertheless, 2411.4 hectares (33.6%) are currently not suitable (NS1) and 515 hectares (7.2%) are considered permanently not suitable (NS2) with presence several limiting factors.

Pepper

The current suitability of the study area for growing pepper is observed in five classes (Table 9 and Figure 3c). An area of 1059.8 hectares (14.8 % of the total area) has a suitable class (S2). Also, 998.6 hectares (13.9%) are of a moderately suitable class (S3). In addition, 2400.1 hectares (33.5%) show a marginally suitable class (S4), 1775.4 hectares (24.8%) are currently not suitable. Furthermore, 932.7 hectares (13%) exhibit a permanently not suitable class (NS2) due to several limiting factors.

Sorghum

Several suitability classes of the investigated soils for sorghum planting are shown in Table 9 and Figure 3d, it was 228.9 hectares, 3.2 % are suitable (S2) and about 1625.8 hectares, 22.7 % are moderately suitable (S3), about 2204.6 hectares, 30.8 % are marginally suitable (4), and about 2973.7 hectares, 41.5 % are currently not suitable (NS1), about 133.5 hectares, 1.9 % are permanently not suitable (NS2).

Maize

The current soil suitability of the investigated area for maize growth is shown in Table 9 and Figure 4a, about 1532.2 hectares, 21.4 % are moderately suitable (S3), about 1392.1 hectares, 19.4 % are marginally suitable (4), and about 3468.0 hectares, 48.4 % are currently not suitable (NS1), about 774.1 hectares, 10.8 % are permanently not suitable (NS2).

Sugar beet

To grow sugar beet in the study area five suitability classes are expected (Table 9 and Figure 4b). Nearly, 108.6 hectares (1.5% of the total area) are highly suitable (S1), and 546.4 hectares (7.6% of the total area) are suitable (S2), 368.9 hectares (5.1%) show a moderately suitable class (S3). Also, 2775.3 hectares (38.7%) are marginally suitable class (S4), 2918.2 (40.7%) are currently not suitable (NS1), 449.1 hectares (6.3) are considered as permanently not suitable class (NS2).

Potato

The investigated soils for potato planting are shown in Table 9 and Figure 4c, only 1477.7 hectares, 20.6 % of the total area) exhibit a moderately suitable class (S3). Also, 4629.5 hectares, 64.6% show currently not suitable (NS1), 1059.3

hectares, 14.8% are permanently not suitable (NS2), with existing several limiting factors.

Tomato

Applying the current suitability of the soils under study for growing tomato about 476.2 hectares (6.6% of the total area) show a suitable (S2) and nearly 771.6 hectares (10.8 %) have a moderately suitable class (S3), 2161 hectares (30.2 %) are marginally suitable (4), 2293 hectares (32%) are currently not suitable (NS1) and 1464.8 hectares (20.4%) are permanently not suitable class (NS2) with occurring several limiting factors (Table 9 and Figure 4d).

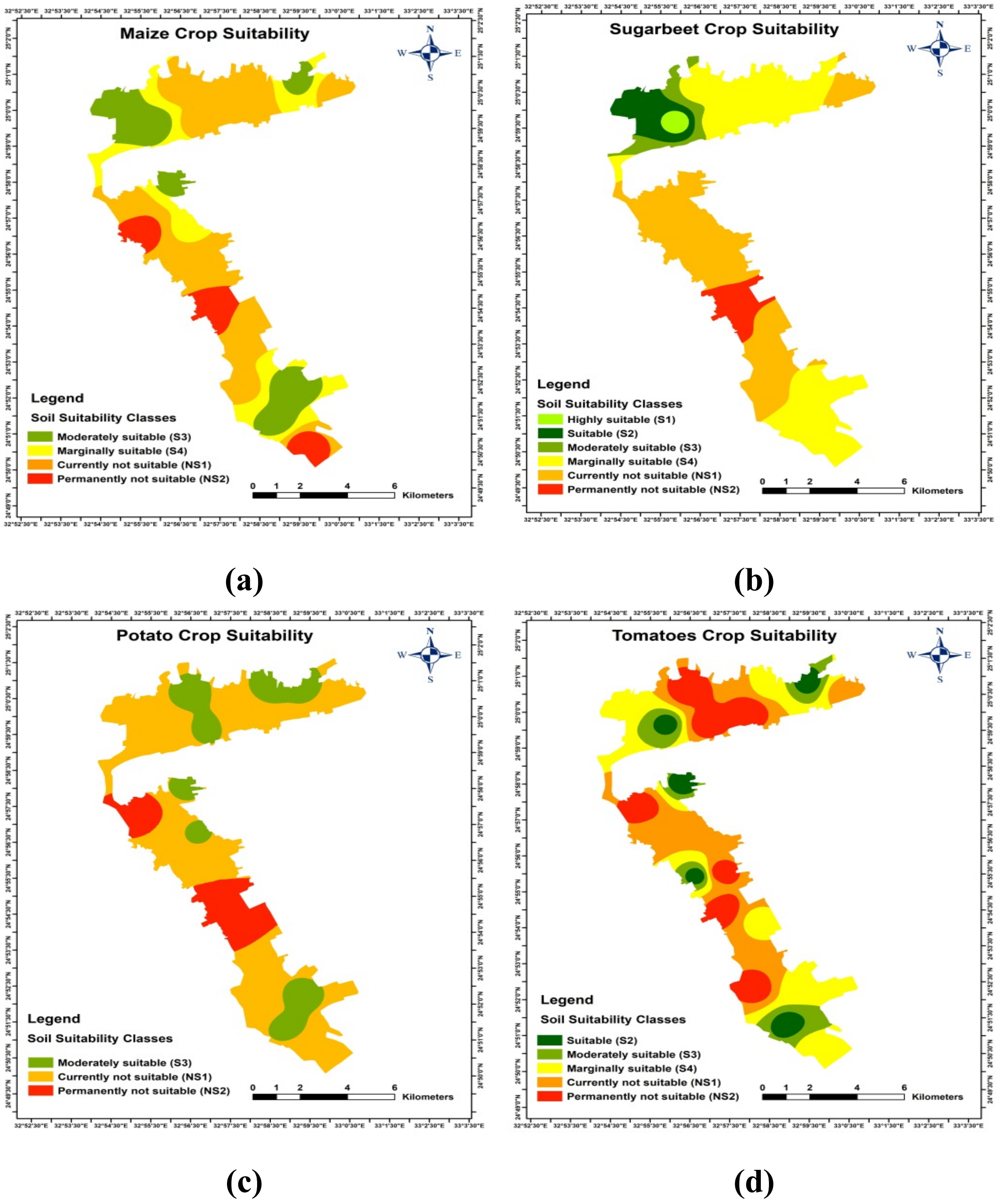
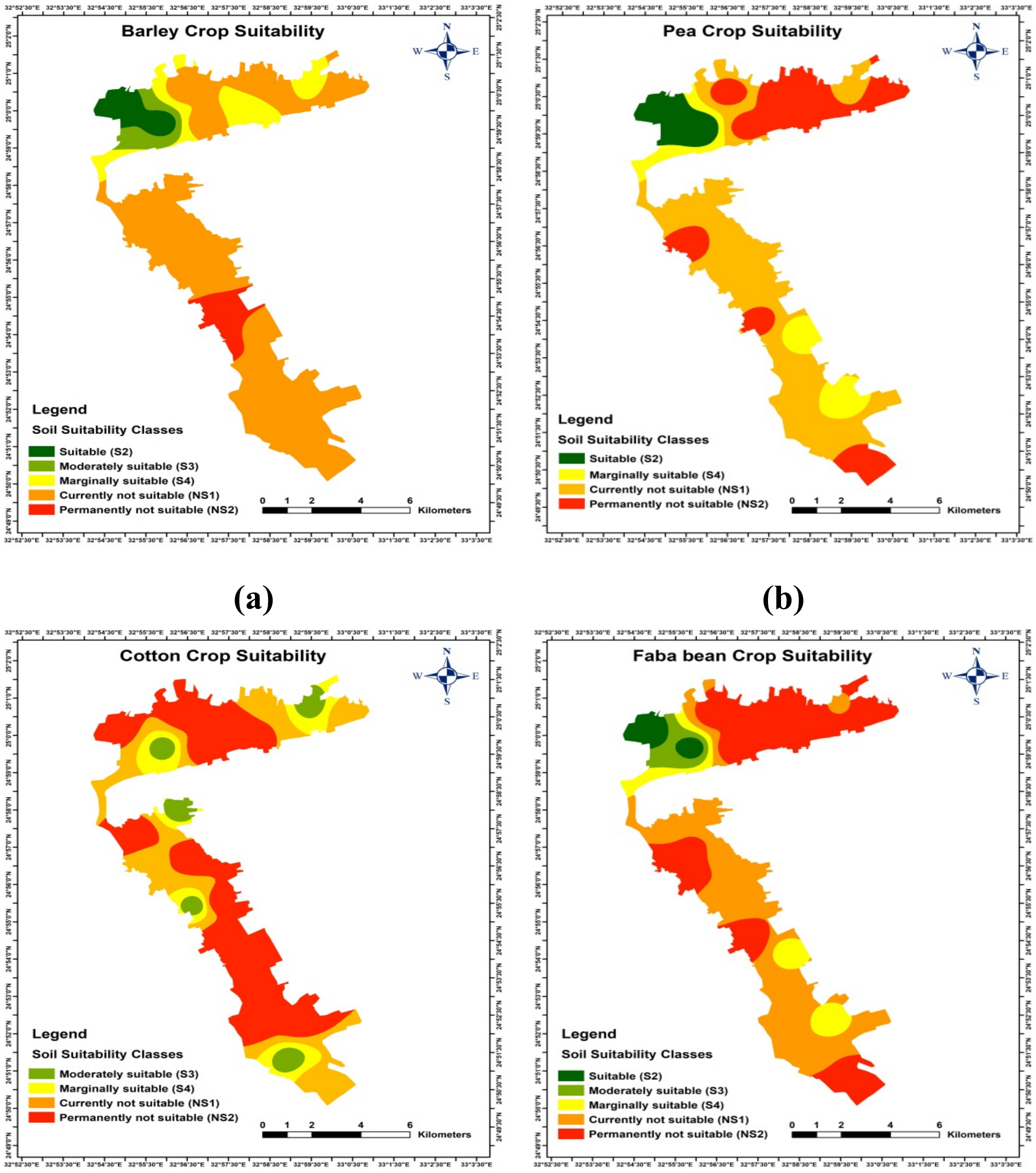


Figure 4. The distribution maps of soil suitability classes for selected crops: a) Maize, b) Sugarbeet, c) Potato, and d) Tomato.

Barley

Applying the current suitability of the soils under study for growing barley about 436.2 hectares (6.1% of the total area) show a suitable class (S3), 326.2 hectares, 4.6 % are moderately suitable class (S3). Also 843.2 hectares, 11.8% are marginally suitable (4), and nearly 5118.6 hectares, 71.4%) have a currently not suitable (NS1), 442.2 hectares, 6.2% are permanently not suitable class (NS2) with several limiting factors (Table 9 and Figure 5a).



(a) (b)

(c) (d)

Figure 5. The distribution maps of soil suitability classes for selected crops: a) Barley, b) Pea, c) Cotton, and d) Fababeen.

Pea

The current suitability of the study area for growing pea was observed (Table 9 and Figure 5b). An area of 600.5 hectares (8.4% of the total area) has a suitable class (S2). Also, 837.9 hectares (11.7%) are of a marginally suitable class (S4). In addition, 3696.8 hectares (51.6%) show a currently not suitable class (NS1), 2031.3 hectares (28.3%) exhibit a permanently not suitable class (NS2) due to several limiting factors.

Cotton

Soils that are suited to be grown by cotton in the study area are assorted into three suitability classes (Table 9 and Figure 5c). A very small area of 512.8 hectares (7.3 % of the total area) has a moderately suitable class (S3). Also, 790 hectares (11%) show a marginally suitable (4) and 2120 hectares (29.6%) are currently not suitable (NS1). However, 3734 hectares (52.1%) exhibit a permanently not suitable class (NS2) with existing soil salinity, texture and CaCO3 content limiting factors.

Fababean

Several suitability classes of the investigated soils for fababean planting are shown in Table 9 and Figure 5d, only 324.9 hectares (4.5% of the total area) exhibit a suitable class (S2). Also, 308.2 hectares (4.3%) show a moderately suitable (S3). However, 649 hectares (9.1%) show a marginally suitable (4), 3046.3 hectares (42.5%) are currently not suitable (NS1), 2838.2 hectares (39.6%) exhibit a permanently not suitable class (NS2) with existing soil salinity, texture and CaCO3 content limiting factors.

Wheat

The soils under study could be categorized regarding the current suitability for wheat growth into five classes (Table 9 and Figure 6a). Nearly, 426.6 hectares (6.0 % of the total area) have a suitable class (S2); 325.7 hectares (4.5%) show a moderately suitable class (S3) and 470 hectares (6.6%) have a marginally suitable class (S4). Also, 5502.1 hectares (76.8%) show a currently not suitable (NS1). Nonetheless, 442.2 hectares (6.2%) are considered permanently not suitable (NS2) due to presence of several limiting factors.

Onion

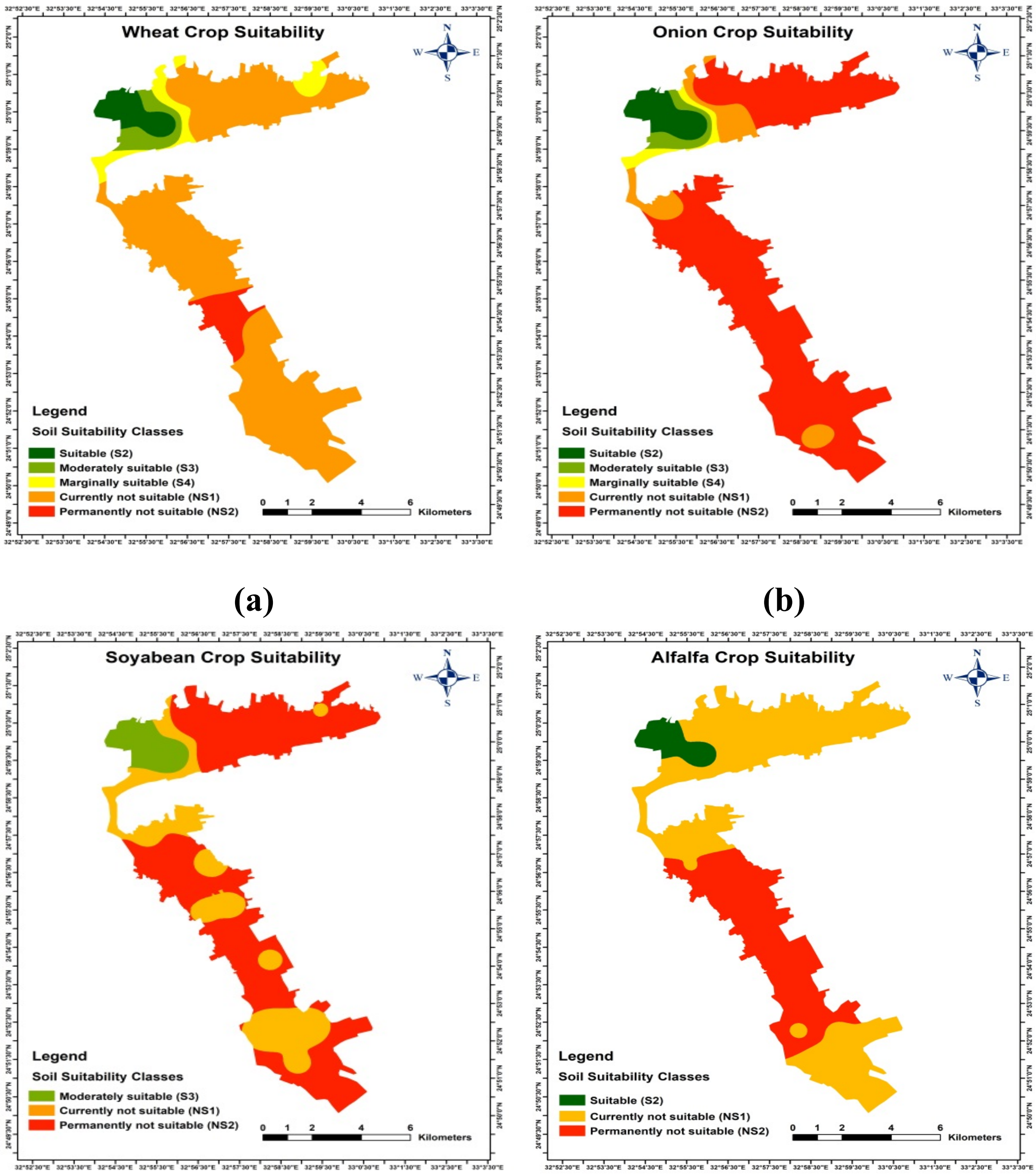
The current suitability distribution to grow onion on the studied soils indicates that 489.3 hectares (6.8% of the total area) was suitable class (S2), 233.2 hectares (3.3%) are moderately suitable class (S3) and 188.4 hectares, (2.6%) have a marginally suitable (S4) (Table 9 and Figure 6b). In addition, 691.5 hectares (9.6%) are currently not suitable (NS1). On the other hand, the majority of the study area, 5564.0 hectares, and 77.6% are considered permanently not suitable (NS2) due to occurrence of several limiting factors.

Soyabean

Only three suitability classes occur in the study area for growing soyabean (Table 9 and Figure 6c). About 571.4 hectares (8% of the total area) have a moderately suitable class (S3), 2007.1 hectares, (28%) are currently not suitable class (NS1). In addition, most of the study area of 4588 hectares, 64% are considered permanently not suitable (NS2) due to several limiting factors.

Alfalfa

The current suitability distribution to grow alfalfa on the studied soils indicates that 426.6 hectares (6 % of the total area) was suitable class (S2) (Table 9 and Figure 6d). In addition, 4226.2 hectares (59%) are currently not suitable (NS1). On the other hand, 2513.8 hectares, 35.1% are considered permanently not suitable (NS2) due to occurrence of several limiting factors.

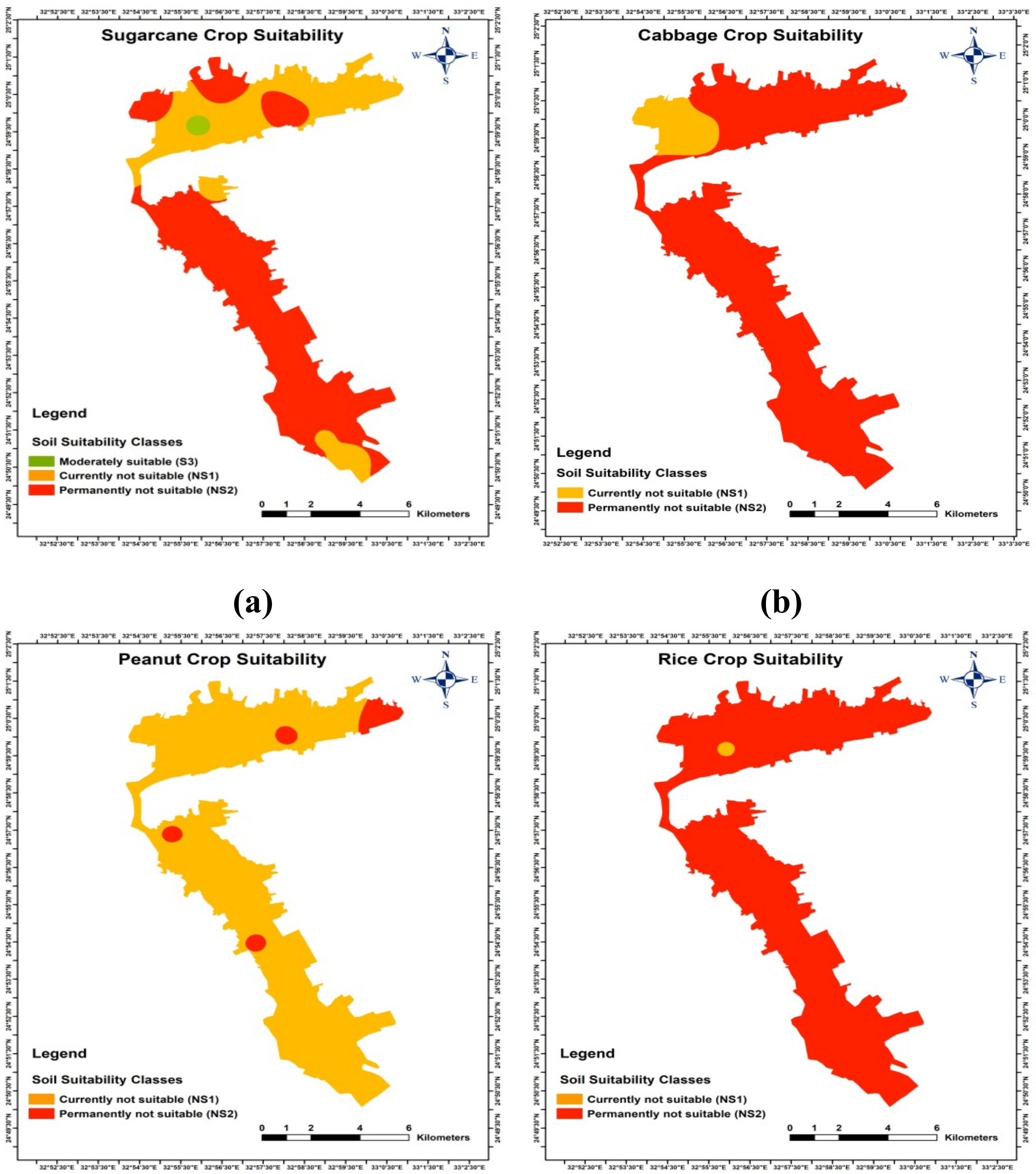


(a) (b) (c) (d)

Figure 6. The distribution maps of soil suitability classes for selected crops: a) Wheat, b) Onion, c) Soyabean, and d) Alfalfa.

Sugarcane

The soils under study could be categorized regarding the current suitability for sugarcane growth into three classes (Table 9 and Figure 7a). Nearly, 78.8 hectares (1.1% of the total area) have a moderately suitable class (S3). Also, 2454.9 hectares (34.3%) show a currently not suitable one (NS1). Nonetheless, 4634 hectares (64.7%) are considered permanently not suitable (NS2) due to presence of several limiting factors.



(a) **(b)**

(c) **(d)**

Figure 7. The distribution maps of soil suitability classes for selected crops: a) Sugarcane, b) Cabbage, c) Peanut, and d) Rice.

Cabbage

The results of Table (9) and Figure (7b) display the current suitability distribution of the examined soils for growing cabbage. Nearly, 710.2 hectares (9.9% of the total area) are currently not suitable (NS1). However, the majority of study area 6456.4 hectares, (90.1%) are permanently not suitable (NS2) as the soil salinity, texture and CaCO3 content are the limiting factors.

Peanut

For growing peanut, the distribution of the current suitability of the soils under study shows that 6797.5 hectares (94.9% of the total area) has are currently not suitable (NS1) (Table 9 and Figure 7c). About, 369 hectares (5.1% of the total area), are considered permanently not suitable (NS2) for agricultural use with several more limiting factors.

Rice

Table (9) and Figure (7d) declare the distribution of current suitability of the study area for rice planting. A small area of 39.7 hectares, 0.6% of the study soils have a currently not suitable (NS1). However, the majority of area 7126.9 hectares, 99.4 % of the study soils are permanently not suitable for agricultural use (NS2). According to the Sys *et al*. (1991 and 1993) rating tables, crops are considered unsuitable to grow on most of the studied soils due to their moderate to severe limitations of high salinity, coarse texture, alkalinity, high CaCO3 content and low fertility; Fababean, wheat, onion, soya bean, alfalfa, sugarcane, cabbage, peanut, rice, are considered unsuitable crops (NS1 and NS2) for all soils under study. Proper fertilization and management associated with intensive leaching using good quality irrigation water can improve the soil suitability to grow various crops under consideration.

Conclusions

The current study was carried out to assess and map the soil suitability of east Edfu region soils. Soil samples were collected from twenty sites, representing an area of 7166.52 ha. The results revealed that soils under study are characterized by a coarse texture, as the dominant texture classes were loamy sand and sandy loam. Regarding the soil depth, the soils of the investigated sites have a moderate limitation for agricultural land use. The lime content that is less than 10% dominates in most of the studied soil sites. Most of these soils have slight to moderate limitations for the salinity. For soil sodicity (ESP), about 90 % of the total study area has an ESP value that is less than 15%. The coefficient of variation (CV) differs from one variable to another and it varies from 0.0 to 271.6 %. It indicates that the variability is low for the particle density, pH, porosity, bulk density and sand, moderate for OM and SP, and high to very high for the rest of properties. Furthermore, evaluation of soil suitability for growing the selected crops under study area, revealed that sunflower, watermelon, pepper, sorghum, maize, sugarbeet, potato, tomato, are suitable and moderately suitable crops for these soils with S2, S3 classes. The present research study recommends that soils in the study area should be taken into account by decision-makers and farmers by applying suitable agricultural practices to minimize limitations and maximize their productive capability potential and suitability for crops.

References

Abd El-Azem, A.H., (2020). Multidisciplinary Studies to Evaluate the Agricultural Sustainability of Desert Fringes Soils, West Edfu, Aswan, Egypt. Ph.D. Thesis, Faculty of Agriculture and Natural resources, Aswan, Aswan University, Egypt.

Blake G.R. and Hartge, K.H. (1986). Particle density. P. 377-382. In A. Klute (ed.) "Methods of Soil Analysis" part 1. Physical and Mineralogical Methods. Agron. Monogr. 9. 2nd ed. ASA and SSSA. Madison. WI.

Bodman, A.G. (1946). Memiographed laboratory notes on soil characteristics. University of California, U.S.A.

Brejda, J.J., Moorman, T.B., Karlen, D.L., *et al*. (2000). Identification of regional soil quality factors and indicators: I. Central and southern high plains. Soil Science Society of America Journal, 64: 2115-2124.

Cambardella, C.A., Moorman, T.B., Novak, J.M., *et al*. (1994). Field-scale variability of soil properties in central Iowa soils. Soil Science Society of America Journal, 58; 1501-1511.

Cambardella, C.A., Karlen, D.L., (1999). Spatial analysis of soil fertility parameters. Precision Agriculture 1(1): 5-14.

Danielson, R.E. and Sutherland, P.L. (1986). Porosity. In: Klute, A. (ed.), Methods of Soil Analysis. Part 1: Physical properties. American Society of Agronomy, Madison, 443-460.

Hesse, P.R. (1998). A Textbook of soil chemical analysis. CBS Publishers & Distributors. Delhi, India.

Ismail, H.A.; Morsy, I.; El-Zahaby, E.M. and El-Nagar, F.S. (2001). A developed expert system for land use planning by coupling land information system and modeling. Alex. J. Agric. Res. 46 (3): 141.

Jackson, M.L. (1967). Soil Chemical Analysis. Prentice-Hall., Inc., Englewood Cliffs, New Jersey, USA.

Jackson, M.L. (1973). Soil Chemical analysis. Prentice-Hall of India private Limited New Delhi.

Jenny, H. (1980). The Soil Resource: Origin and Behavior. Ecological Studies Vol.37. Springer-Verlag, New York, USA.

Piper, C.S. (1947). Soil and Plant Analysis. Inter. Science Publishers Inc. New York.

Quine, T.A., Zhang, Y. (2002). An investigation of spatial variation in soil erosion, soil properties and crop production within an agricultural field in Devon. U.K. Journal of Soil and Water Conservation, 57: 50-60.

Richards, L.A. (1954). Diagnosis and Improvement of Saline and Alkaline Soils. United States Dept. of Agric., Handbook No. 60.

Sys, C. (1979). Land Evaluation Criteria for Irrigation. Report of an Expert Consultation Held in Rome. Volume 50.

Sys, C., Van Ranst, E., and Debaveye, J. (1991). Land evaluation: Part I and II. Belgium General Administration for Development Cooperation. Agricultural Publications No.7.

Sys, C., Van Ranst, E., Debaveye, J., and Beernaert, F. (1993). Land Evaluation: Part III-Crop requirement. Belgium General Administration for Development Cooperation, Agricultural Publications. 191 pp.

Vieira, S.R., Paz Gonzalez, A. (2003). Analysis of the spatial variability of crop yield and soil properties in small agricultural plots. Bragantia (Campinas), 62: 127-138.

Walkley, A. and Black, I.A. (1954). Determination of Organic Matter. Soil Sci., 37: 29–38.

Wilding, L.P. (1985). Spatial variability: Its documentation, accommodation, and implication to soil surveys. In Soil spatial Variability. D. R. Nielsen and J. Bouma (eds). Pudoc. Wageningen, The Netherlands, pp. 166-194.

Zamil, B.A; Abd Allah, M.A., Abd El-Salam, G.M. and El-Shahawy, M.I. (2009). Land Evaluation of Old Irrigated Soils in North Delta Region (Rewena Canal Area) at Kafr El Sheikh Governorate. 1Soils, Wate. and Env. Res. Inst., Argric. Res. Center, Egypt.

تقييم ملائمة التربة لزراعة عشرين محصولاً لمنطقة شرق إدفو، أسوان

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الملخص

تقييم ملائمة التربة أمر بالغ الأهمية لتخطيط الاستخدام المستدام للأراضي. تعتبر منطقة شرق إدفو بمحافظة أسوان مهمة للإنتاج الزراعي. لذلك هدفت هذه الدراسة إلى تحديد وتقييم ورسم خريطة لملائمة التربة لزراعة عشرين محصولًا مختارًا في منطقة الدراسة باستخدام برنامج Asle. تم اختيار عشرين موقعًا لأخذ العينات في شرق إدفو تمثل مساحة 7166.52 هكتارًا للدراسة الحالية. تم تسجيل جميع إحداثيات الموقع التي تم أخذ عينات منها باستخدام جهاز نظام الموقع العالمي (Gps) ثم تم رسمها على خريطة باستخدام ArcGIS. تم جمع عينات التربة من كل موقع على عمق 0-60 سم. علاوة على ذلك، تم تحديد الخصائص الفيزيائية والكيميائية للتربة (على سبيل المثال، قوام التربة، وعمق التربة، ومحتوى كربونات الكالسيوم، والملحية ومعدل إدمصاص الصوديوم) والتي ترتبط ارتباطًا جوهريًا باستخدام التربة وقيودها المحتملة. علاوة على ذلك، تم إنتاج خرائط التوزيع المكاني لملائمة التربة لجميع المحاصيل المختارة باستخدام برنامج ArcGIS. أوضحت النتائج أن التربة قيد الدراسة تتميز بقوام خشن، حيث كانت فئات النسيج السائدة هي الرملي الطميي والطميي رملي. فيما يتعلق بعمق التربة، فإن تربة المواقع التي تم فحصها لها قيود معتدلة على استخدام الأراضي الزراعية. محتوى الجير أقل من 10٪ في معظم مواقع التربة المدروسة. معظم هذه التربة لها حدود طفيفة إلى معتدلة للملوحة. بالنسبة للصوديوم المتبادل (ESP)، يحتوي على حوالي 90٪ من مساحة الدراسة الإجمالية على قيمة ESP أقل من 15٪. كما أظهرت النتائج أن دوار الشمس والبطيخ والفلفل والذرة الرفيعة والذرة والبنجر والبطاطا والطماطم تعتبر محاصيل مناسبة ومناسبة إلى حد ما لهذه التربة.