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Assessment of Land Suitability for Surface and Drip Irrigation Systems in the Northwestern Coast of Egypt

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THIS WORK aimed at the assessment of the land suitability for surface and drip irrigation systems in a part of west Matrouh area, northwestern coast of Egypt. For establishing this target, a digital elevation model (DEM) and SENTENAL-2 image were used for identifying the physiographic units of the studied area. The integration between satellite image and soil survey using Arc-GIS10.9 software was done to produce the different maps of this work. These properties were used for assessment the land suitability. The studied area have nine landform units, including coastal plain, alluvial plain, sloping area, escarpment, coarse valley inner, coarse valley outer, low piedmont, Moderately high piedmont and high piedmont. Thirty-one soil profiles were selected to represent these different landform units and described morphologically .Soil samples were collected according to the vertical variations of each profile for physiochemical properties and analyzed. Results of land suitability assessment indicated that, the studied soils could be categorized as suitable (S) and currently not suitable (N1) for surface irrigation. Marginally suitable soils (S3) covered nearly 64% of the total area, while the remaining area was occupied by moderately suitable soils (S2) and those of N1 class (31%). The most limiting factors are texture, soil depth, drainage and excess of $CaCO_3$ content. The land suitability assessment for drip irrigation system indicated that, the soils are highly suitable (S1) in 2% of the area, moderately suitable in 56% and marginally suitable in 42% of the area. This shows that,the drip irrigation is more benefit than the surface irrigation in this area.

Key word: Land suitability assessment, Surface and drip irrigation, Northwest of Egypt

Introduction

Adding new agricultural areas especially outside the Nile valley and The Delta is one of the main aspects of the Egyptian strategic target to provide the food to cope overpopulation (Darwish et al. 2006 and Ismail et al. 2005). Saving water and take advantage of the amount of rainfall should be used to fill the water deficit as a result of the increase in the population (Ibrahim, 2019) and the construction of storage dams on the Nile in the upstream country (Ethiopia). A good attention is directed to the Egyptian northwestern coastal area, for its suitable amount of rainfall. The most limiting factors affect the land suitability for agriculture in this area are soil texture, shallow soil depth, soil drainage and excess of $CaCO_3$ content (Yousif, 2019). For keeping continuous soil development, studies on management of land and water resources are necessary (Ali, 2008). It is necessary to evaluate the suitability of land for surface and drip irrigation types (Albaji et al. 2010). Land evaluation helps decision makers in sustainable management of agricultural resources (Hoda, 2020) Drip irrigation system is more benefit than the surface one where the mean of capability index for surface and drip irrigation are 48.6 and 59.1 respectively (Abdel Ghaffar, 2016 and El Husieny et al., 2020). FAO (1976) established a system for land evaluation depend on soil and available irrigation water properties. Sys et al. (1991) and Bagherzadeh & Mansouri (2011) established and modified system toevaluate the land suitability for irrigation system such as

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surface and drip which based on soil physical, chemical, drainage and slope.

The north western coast of Egypt hasa priority for rainwater harvesting with agriculture potential benefits by some field crops and horticulture trees (Abdel Ghafar etal. 2019). On farm level a lot of water have to apply using surface system to escape degradation of soil and lack of yield, irrigation water and irrigation methodsshould be in line with the land properties. For this reason, it is necessary to evaluate the suitability of land for surface and drip irrigation (Abdel Ghaffar 2016). Remote sensing (RS) should be used as an aid to distinguish landscape elements. Qualitative models derived from modification of soil landscape models are efficient means of interpolation point data based on conceptual relationship between observation of the soil property or condition being mapped and easily observable landscape features (Peterson et al. 1996). Geographic Information System (GIS) used to query, link and retrieveboth of spatial attribute data (Abowaly et al. 2018). This is in integration with the physical features can create a new data and predictive models that could be this is important for planners and decision makers (Ahmed et al., 1998). The aim of this study isassessment the soil suitability for surface and drip irrigation systems in a part of west Matrouh area, northwestern coast of Egypt,to have the optimum utilization of soil using remote sensing and GIS analysis. West Matrouh area located in the northwestern part of Egypt was selected as case study for this approach.

Materials and Methods

Location of the studied area

The study area located in Northwestern coast of Egypt between Longitudes 31° 26' 56" E to 27° 6' E and Latitudes 31° 15' Nto 31° 27' N (Fig. 1). It covers an area of about 276.4km^2 (nearly 27636 ha) with about 20 km long and 15 km width.

Climate of the study area

Data in Table 1 presented the yearly average metrological data of the study area over the years from 2001 to 2015 obtained from Matrouh metrological station (CLAC, 2015). According to UNESCO (1977), the study area is considered as arid with mild winter and hot summer.The mean maximum annual temperature is 25.9 ºC and the minimum is 15.55 °C. The mean annual rainfall in this period ranging from 60. 9 to 263 mm (Table.1). The maximum and minimum annual relative humidity are 62.64% and 68.47% respectively. Wind velocity varies from 15.10 to 20.89 kmhr^{-1}.

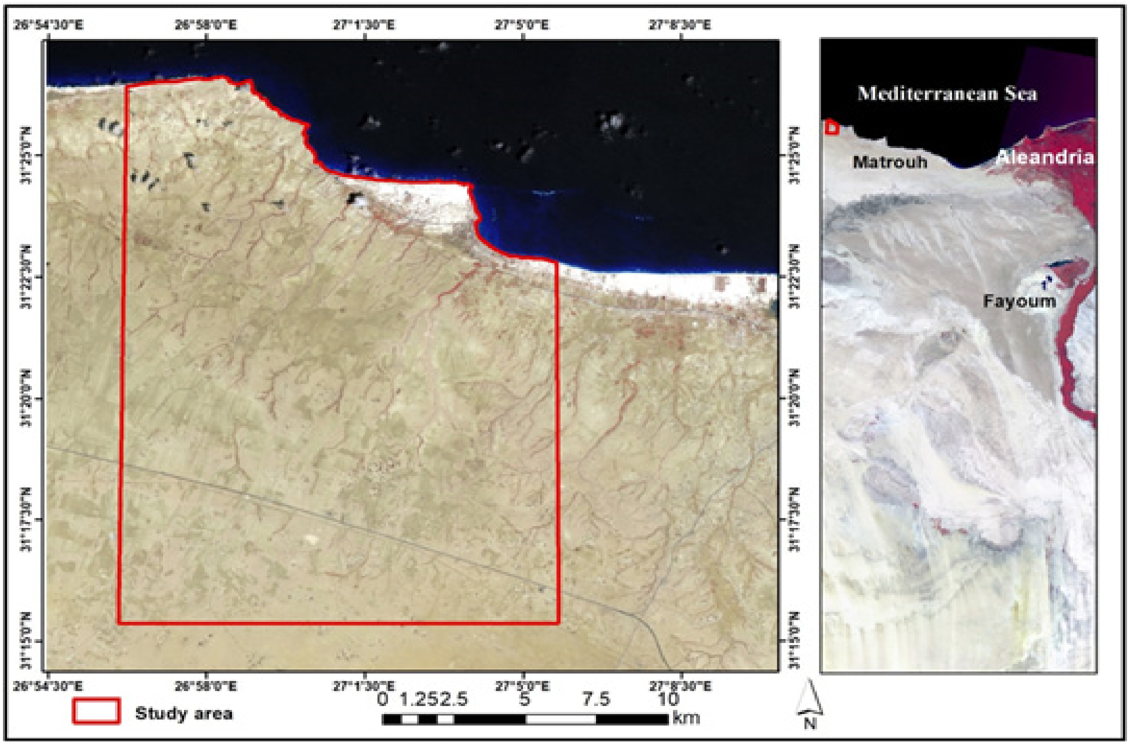

Fig. 1. Location map of the studied area

TABLE 1. Metrological data of studied area (CLAC 2015)

Year	Temperature (C ⁰)			Rainfall (mm)	Relative Humidity (%)	Wind Velocity,km hr^{-1}	See level Pressure hpa
	min	max	mean				
2001	15.55	24.98	20.34	98.30	66.25	17.70	1015.60
2002	15.70	24.81	20.36	183.10	67.03	15.10	1015.74
2003	15.57	24.72	20.14	160.53	66.40	15.93	1014.92
2004	15.55	24.54	20.07	93.98	62.63	16.53	1015.82
2005	15.94	24.13	20.03	103.37	62.34	18.27	1015.88
2006	15.67	24.40	20.00	114.55	65.55	19.94	1015.63
2007	15.75	24.48	20.17	263.13	67.52	20.89	1015.26
2008	16.05	25.21	20.68	137.16	65.74	16.36	1015.67
2009	15.80	24.76	20.38	109.50	63.28	15.73	1014.71
2010	16.48	25.90	21.13	87.12	62.98	17.98	1014.38
2011	15.59	24.42	20.03	185.72	66.06	17.13	1015.38
2012	16.34	25.07	20.71	103.62	67.11	18.83	1014.55
2013	16.08	25.01	20.52	120.39	67.48	19.95	1014.92
2014	16.06	25.43	20.71	60.96	68.20	18.30	1015.50
2015	15.75	25.15	20.38	86.37	68.47	18.47	1016.23
Average	15.86	24.87	20.38	127.1	65.80	17.80	1015.35

* hpa:hectopascals= (10^2 pascals).

Geology of study area

The study area is characterized by a sedimentary cover (Fig. 2) ranging from Tertiary to Quaternary age (Zahran 2008). Quaternary is widely found in the coastal and wadi plain in the northern section, The Pliocene and Miocene of the Tertiary age is exposed major part of the tableland. Plateau formation is the main structure in middle and south of investigated area in Tertiary Miocene composed of limestone (El-Shazely et. al., 1975. Area lies between the shoreline and Libyan plateau is mostly composed of calcareous Pliocene and Pleistocene formations and covered by Recent deposits (Shata, 1971).

Remote sensing and GIS work

Satellite data

SENTENAL-2 image including 13 spectral bands which has characteristics as shown in Table 2 taken in 20th August 2018, using band combination of 8,4,3 bands as RGB channels and topographic maps of the investigated area scale 1:100000 were used in this study for identifying the physiographic features of the study area.

Physiographic mapping units of the studied area

Topographic maps of the investigated area (scale 1:100000) and SENTENAL-2 image were used in this study to delineate the physiographic mapping units. The extracted data form topographic maps are contour line and spot heights (Fig. 3). Dgital Elevation Model (DEM; Fig. 4) of the study area have been generated from the vector contour lines, the elevation points recorded during the field survey by GPS were also used to enhance the digital elevation model, ARC, GIS 10.3 software used for this function. Dragging (DEM) on SENTENAL-2 in ERDAS Imagine software was done to establish the physiographic map of the studied area (Dobos et al. 2002 and Zinck and Valenzula, 1990).

Field work

A field survey was carried out essentially to define the soil characteristics of the different physiographic units in the study area. Thirty-one soil profiles representing these physiographic units were excavated to 150 cm depth or to impervious layer whichever is shallower. Locational map of the studied soil profiles is shown in Fig. 5. The soil profiles were morphologically described according to FAO (2006). Samples were taken from the different horizons of each profile for the lab-analysis.

TABLE 2. Spectral channels bands properties of sentinel-2

Band number	Band name	Sentinel-2A		Sentinel-2B		Resolution m
		Central wavelength (nm)	Bandwidth (nm)	Central wavelength (nm)	Band width (nm)	
1	Coastal aerosol	443.9	20	442.3	20	60
2	Blue	496.6	65	492.1	65	10
3	Green	560	35	559	35	10
4	Red	664.5	30	665	30	10
5	Vegetation Red Edge	703.9	15	703.8	15	20
6	Vegetation Red Edge	740.2	15	739.1	15	20
7	Vegetation Red Edge	782.5	20	779.7	20	20
8	NIR	835.1	115	833	115	10
8b	Narrow NIR	864.8	20	864	20	20
9	Water vapour	945	20	943.2	20	60
10	SWIR – Cirrus	1373.5	30	1376.9	30	60
11	SWIR	1613.7	90	1610.4	90	20
12	SWIR	2202.4	180	2185.7	180	20

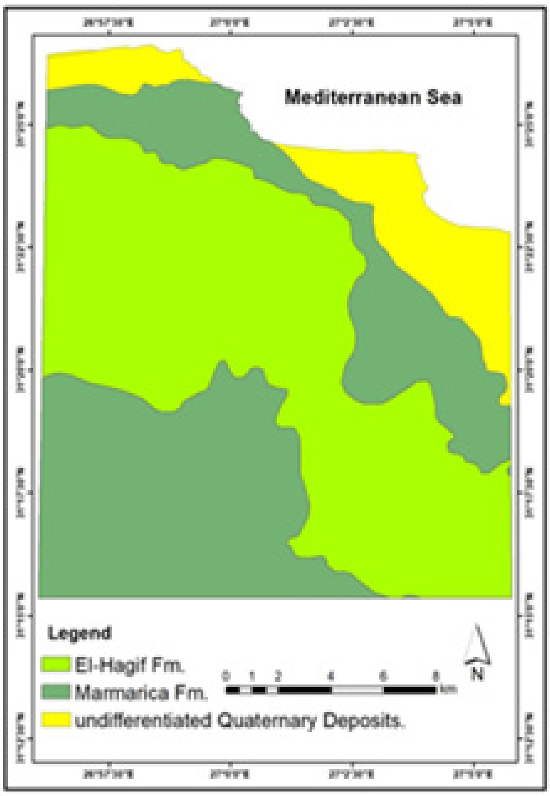

Fig. 2. Geological map of studied area

Laboratory analyses

The collected soil samples were air dried, crushed, sieved through a 2 mm sieve and the fine earth samples (< 2 mm) were stored in plastic bags for physical and chemical analyses as follows. Particle size distribution of the fine earth samples was carried out by pipette methods; after removing salts, without removing calcium carbonate, using sodium hexametaphosphate as a dispersing agent, according to Jackson (1973). Calcium carbonate content was estimated volumetrically using Collin's Calcimeter (Burt, 2004).

The following chemical analyses were performed according to the procedures outlined by Burt (2004). Soil reaction (pH) was determined in 1:2.5 soil water suspensions. Electrical conductivity (ECe) and the soluble ions were determined in soil paste extract. Organic matter was determined by wet oxidation method. Also, gypsum content was determined according to Burt (2004).

Land suitability assessment

To assessment the land suitability for surface and drip irrigation systems, main soil parameters are required. The soil parameter used in this assessment are those explained by Sys and Verheye (1978) and modified by Bagherzadeh and Mansouri Daneshvar (2011) and Sys et al. (1991)according to intensity of limitation factors showed in Table 3. These parameters are the morphological, physical and chemical soil characteristics. The rate of each parameter has given a value from 0 to 100. Six parameters (topography (A), drainage (B), electrical conductivity (C), calcium carbonate content (D), soil texture (E) and soil depth "F") were considered and ratedfor every parameter.The suitability index (Si) for each irrigation system was calculatedfrom the following equation:

$$Si = A x B/100 x C/100 x D/100 x E/100 x F/100 x G/100$$

Results And Discussion

Physiographic units of the study area

The study area is characterized by nine landform units. These landform units are coastal plain, alluvial plain, sloping area, escarpment, inner coarse valley, outer coarse valley, low piedmont, moderately high piedmont and high piedmontas presented in Fig. 5 and Table 4.

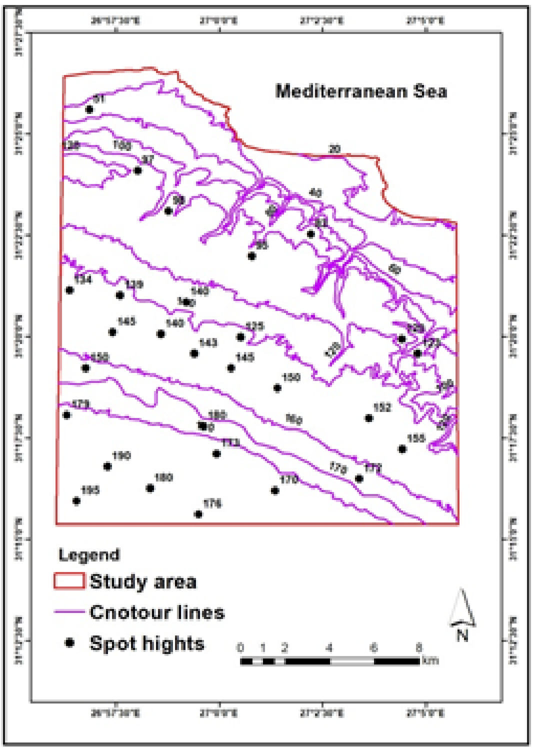

Fig. 3. Contour lines and spot hights

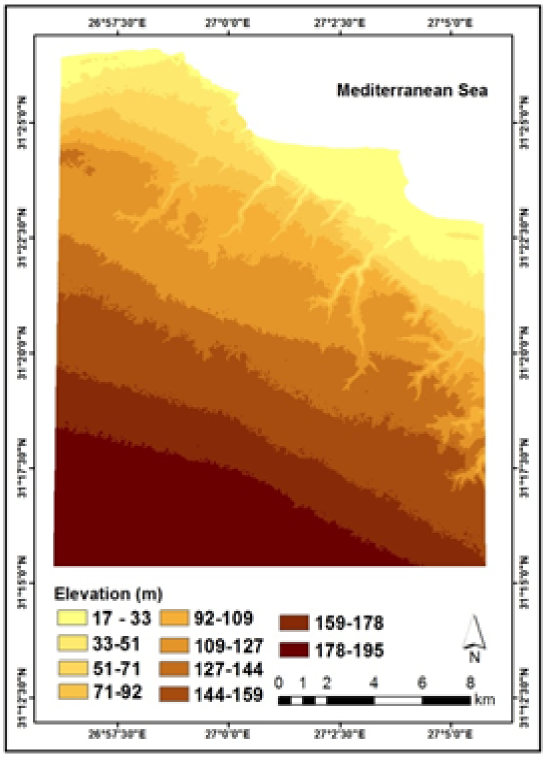

Fig. 4. Digital elevation model (DEM)

TABLE. 3. Land suitability classes according to degree of limitations

Soil class	Intensity of limitation	Definition	Suitability index
S1	Slight limitations	Highly suitable	75-100
S2	Moderate limitations	Moderately suitable	50-75
S3	Severe limitations	Marginally suitable	25-50
N1	Very severe (modifiable)	Current not suitable	12.5-25
N2	Very severe (non modifiable)	Permanently not suitable	0-12.5

TABLE 4. Detailed physiographic units and their areas in the study area

Environmental deposits	Landscape	Relief	Lithology	Landform	Area km²	Area %
Recent coastal deposits	plain	Sea Beach	Undifferentiated quaternary deposits	Coastal Plain	15.6	5.7
		Sand sheet	Wadi deposits	Alluvial plain	18.7	6.8
		Sand sheet	Marmarica formation	Sloping area	27.1	9.8
Marine limestone with marl	Northern plateau	plateau	Elhagif formation	Escarpment	13.7	5.0
		Coarse valley	Elhagif formation	Coarse valley inner	8.9	3.2
				Coarse valley outer	19.4	7.0
		plateau	Elhagif formation	Low piedmont	63.4	22.9
				Moderately high piedmont	70.1	25.4
	Southern plateau	plateau	Marmarica formation	High piedmont	39.5	14.3
Total					276.4	100

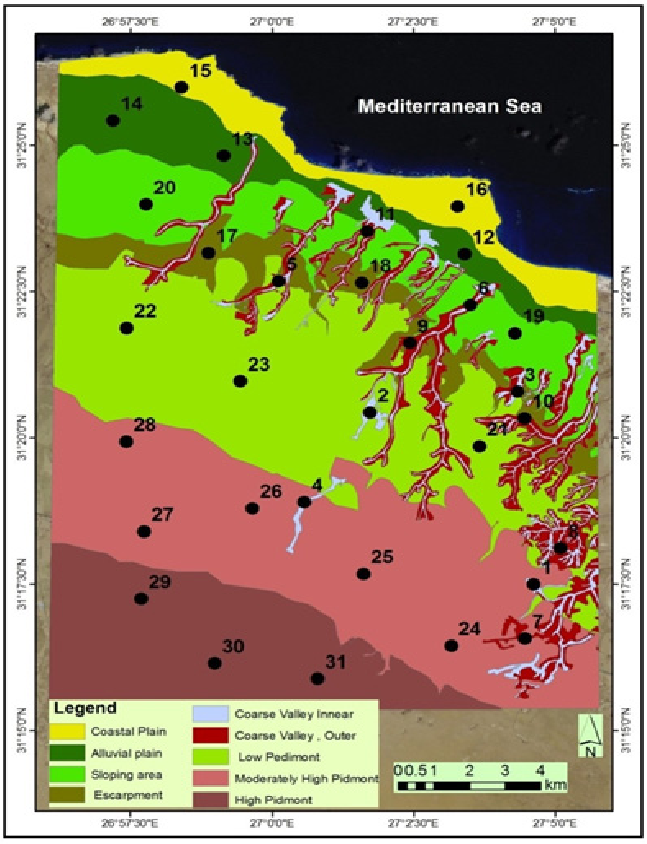

Fig. 5. Detailed physiographic map of the study area and profiles location

Soil properties

The morphological features of the studied soils showed that, these soils have almost flat to gently undulating topography. The soil surface is covered with fine sand and few grass shrubs. The soils have different texture varied from loamy sand to sandy clay. They are highly calcareous having 14.4 to 32.4 % $CaCO_3$ content (Table 5). The analytical data in Table 5 reveal that, the soils are slightly to moderately alkaline having pH values between 7.6 to 8.1. These soils are non- to moderately -saline with ECe values between 1.2 to 9.7 dSm^{-1}. Organic matter content is very low (<0.44 %). Gypsum content is low not exceeds 1.9 %

Land suitability for surface irrigation system

Land suitability indices and classes for surface irrigation system presented in Table 6 and Fig. 6 show that the studied soils are classified into three suitability classes namely S2, S3 and N1 which described as follows:

- Moderately suitable (S2) class is including a few areas of about 14.6 km^2 forming about 5.3% of the studied area (Table 8). This class contains most soils of inner coarse valley unit except soils of profiles 3 and 6 (Table 6). It also includes soil of profile 14 in alluvial plain unit. The main limitations effect this class is light soil texture and high $CaCO_3$ content.

- Marginally suitable (S3) class covers most of the studied areas (64.2%) with about 177.4 km^2 (Table 8). These soils have severe limitations of light soil texture, shallow depth and high $CaCO_3$ content.

TABLE 5. Some soil properties for representative profiles of studied area

Profile No.	Depth (cm)	pH	EC ds m^{-1}	Sand %	Silt %	Clay %	Texture class	$CaCO_3$ %	O.M %	Gypsum %
					Coarse valley inner					
1	0-30	7.9	2.3	75.3	18.2	6.5	loamy sand	17.3	0.28	0.7
	30-70	7.94	3.06	48.8	27.0	25.0	sandy clay loam	29.04	0.21	1.1
	70-110	7.9	3.88	46.0	25.0	29.0	sandy clay loam	28.05	0.24	1.5
2	0-30	8	2.4	48.5	26.0	25.5	sandy clay loam	27.75	0.37	0.7
	30-70	7.97	2.26	46.0	26.5	27.5	sandy clay loam	28.76	0.32	0.11
	70-120	7.97	1.2	47.5	25.5	27.0	sandy clay loam	24.42	0.31	0.9
3	0-20	7.99	2.42	45.3	26.5	28.2	sandy clay loam	28.75	0.25	0.19
	20-55	7.99	3.3	59.5	25.0	25.5	sandy clay loam	29.42	0.18	0.11
4	0-30	7.99	2.5	65.0	22.8	12.2	sandy loam	24.3	0.27	0.06
	30-60	7.7	2.1	55.5	18.0	25.5	sandy clay loam	32.4	0.33	0.15
	60-105	7.85	2.3	48.2	26.0	25.6	sandy clay loam	29.37	0.15	0.09
5	0-20	7.95	2.99	53.1	20.2	22.3	sandy clay loam	28.38	0.31	1.8
	20-60	7.95	2.49	69.3	21.7	13.3	sandy loam	25.74	0.28	1.5
	60-110	7.98	1.46	55.5	26.7	27.8	sandy clay loam	29.04	0.15	0.16
6	0-20	7.99	9.7	50.2	23.5	26.3	sandy clay loam	27.74	0.37	0.17
	20-55	7.99	3.28	49.8	24.4	25.8	sandy clay loam	31.38	0.23	0.17
					Coarse valley outer					
7	0-20	7.95	2.46	66.5	20.3	13.2	sandy loam	26.4	0.28	1.9
	20-40	7.84	3.39	74.2	17.3	8.5	sandy loam	23.1	0.31	0.9
8	0-30	7.9	4.25	60.0	25.0	15.0	sandy clay loam	28.38	0.26	1.4
9	0-20	7.6	2.63	65.5	22.0	10.5	sandy loam	21.4	0.27	0.2
	20-60	7.8	4.2	61.3	25.5	13.2	sandy loam	22.39	0.13	0.13
10	0-30	7.8	4.6	72.7	18.0	8.7	loamy sand	14.04	0.27	0.17
11	0-30	7.95	1.75	72.0	20.7	7.3	loamy sand	25.74	0.28	1.1
					Alluvial plain					
12	0-20	7.98	2.58	75.1	17.3	7.6	loamy sand	25.74	0.29	0.8
	20-60	7.88	1.55	65.9	22.5	11.6	sandy loam	25.08	0.15	1.6
	60-110	7.89	1.84	69.0	15.2	15.8	sandy loam	28.38	0.13	0.6

TABLE5. Cont.

Profile No.	Depth(cm)	pH	ECds m-1	Sand%	Silt%	Clay%	Textureclass	$CaCO_3$%	O.M%	Gypsum%
13	0-20	7.8	2.45	74.3	16.4	9.3	loamy sand	28.05	0.44	0.7
	20-60	7.97	1.8	67.8	17.2	12.0	sandy loam	29.3	0.16	0.11
	60-110	7.95	3.0	62.1	23.6	14.3	sandy loam	31.04	0.12	0.13
14	0-20	7.8	6.15	64.8	26.0	16.2	sandy loam	29.32	0.27	0.9
	20-60	7.95	3.25	66.3	17.2	16.5	sandy loam	28.39	0.18	0.17
	60-110	8.0	4.27	63.3	18.4	18.3	sandy loam	27.34	0.12	.019
Coastal plain										
15	0-20	8.1	1.7	67.5	18.2	14.3	sandy loam	19.6	0.25	0.23
	20-45	7.9	2.6	55.7	23.5	20.8	sandy clay loam	28.6	0.18	0.24
16	0-20	7.97	2.6	74.2	18.3	7.5	loamy sand	22.1	0.13	0.17
	20-40	7.98	1.75	74.9	17.3	7.6	loamy sand	25.41	0.15	0.15
Escarpment										
17	0-20	7.79	2.72	65.5	24.5	10.0	sandy loam	21.04	0.15	0.8
	20-45	7.75	3.55	55.6	18.6	25.8	sandy clay loam	29.7	0.17	1.6
18	0-30	7.85	2.14	73.4	10.3	9.3	loamy sand	21.75	0.27	0.17
Sloping area										
19	0-20	8.0	1.25	76.9	15.8	7.3	loamy sand	26.38	0.23	0.15
	20-40	7.9	2.28	74.2	16.8	9.0	loamy sand	27.41	0.11	0.13
20	0-30	7.9	1.68	63.6	17.8	18.6	sandy loam	27.51	0.25	0.19
	30-60	7.97	1.5	62.2	18.5	19.3	sandy loam	29.3	0.13	0.17
Low piedmont										
21	0-20	8.0	3.25	49.0	24	27.0	sandy clay loam	26.4	0.35	1.5
	20-60	8.0	3.28	48.5	24.5	27.0	sandy clay loam	24.2	0.25	0.22
22	0-20	7.98	3.54	70.9	19.8	9.3	sandy loam	28.38	0.24	0.19
	20-40	7.98	5.53	64.2	22	13.8	sandy loam	28.05	0.15	0.2
23	0-20	8.0	2.63	67.0	21.5	11.5	sandy loam	23.71	0.28	0.7
	20-40	8.0	2.67	69.3	20	10.4	sandy loam	22.71	0.19	1.3
Moderately high piedmont										
24	0-20	7.97	5.82	50.0	25	25.0	sandy clay loam	28.11	0.27	1.1
	20-55	7.97	7.00	51.5	22	26.5	sandy clay loam	27.72	0.21	1.5
25	0-20	8.0	2.88	47.5	24.5	28.0	sandy clay loam	29.37	0.26	0.17
	20-45	8.0	4.30	48.0	26.5	25.5	sandy clay loam	26.75	0.19	0.13
26	0-20	7.85	5.12	51.5	23.5	25.0	sandy clay loam	25.74	0.28	0.14
	20-55	8.0	7.87	50.0	20	30.0	sandy clay loam	28.5	0.16	0.25
27	0-30	7.98	2.65	65.2	22.5	12.3	sandy loam	29.37	0.18	1.3
	30-55	7.98	3.58	67.0	21.6	10.8	sandy loam	29.04	0.26	1.7
28	0-20	8.0	3.59	77.5	15.2	7.3	loamy sand	25.41	0.29	1.1
	20-50	7.95	2.54	66.8	20.4	12.8	sandy loam	25.08	0.23	1.7
	50-80	7.95	4.00	64.8	21.6	13.6	sandy loam	25.74	0.11	1.5
High piedmont										
29	0-20	8.0	2.51	75.3	13.2	11.5	loamy sand	23.76	0.18	0.5
	20-60	8.0	3.10	76.5	12.7	10.8	loamy sand	21.74	0.11	0.55
30	0-20	8.0	2.86	72.8	18.6	8.6	loamy sand	22.04	0.26	0.12
	20-55	7.99	2.40	61.2	24.5	14.3	sandy loam	28.38	0.18	0.13
31	0-20	8.0	8.64	74.7	17	8.3	loamy sand	29.7	0.28	0.18
	20-30	8.0	6.83	68.1	21.3	10.6	loamy sand	28.05	0.21	0.19

- Current not suitable (N1) class covers a noticeable proportion (30.5%) from the studied soils with about 84.3 km2 (Table 8). These soils exist in outer Coarse valley (soils of profiles 10 and11), Alluvial plain (soil of profile 13), Coastal plain (soil of profile 16), Escarpment (soil of profile 18), Sloping area (soil ofprofile 19), Low piedmont (soil of profile 22) and in high piedmont (soil of profile 29). These soils have very severe limitations for the surface irrigation system. The overall mean of land suitability index (Si) for the surface irrigation system in the studied area soils is 33.4.

TABLE 6. Suitability of soil profiles for surface irrigation system in the study area

Unit	profile	Texture	Depth	$CaCO_3$	EC	Drainage	Slop	Gypsum	Si	class
Coarse valley inner	1	95	100	90	100	90	95	90	65.8	S2t
	2	95	100	90	100	90	95	90	65.8	S2t
	3	95	80	90	100	65	95	90	38.0	S3d
	4	95	100	100	100	90	95	90	73.1	S2t
	5	75	100	90	100	90	95	90	51.9	S۲t
	6	85	80	90	95	65	95	90	32.3	S3td
Coarse valley outer	7	75	60	100	100	65	95	90	25.1	S3d
	8	95	60	90	95	65	95	90	27.1	S3d
	9	75	80	100	100	65	95	90	33.3	S3d
	10	55	60	90	100	65	95	90	16.5	N1td
	11	55	60	90	100	65	95	90	16.5	N1td
Alluvial plain	12	75	90	90	100	80	95	90	41.6	S3d
	13	75	60	90	95	65	95	90	21.4	N1td
	14	75	100	90	100	90	95	90	51.9	S2t
Coastal plain	15	85	60	100	100	65	95	90	28.3	S3td
	16	55	60	100	100	65	95	90	18.3	N1td
Escarpment	17	95	60	100	100	65	95	90	31.7	S3d
	18	55	60	100	100	65	95	90	18.3	N1td
Sloping area	19	55	60	90	100	65	95	90	16.5	N1td
	20	75	80	90	100	65	95	90	30.0	S3td
Low piedmont	21	95	80	90	100	65	95	90	38.0	S3d
	22	75	60	90	95	65	95	90	21.4	N1td
	23	75	60	100	100	65	95	90	25.1	S3td
Moderately high piedmont	24	95	80	90	95	65	95	90	36.1	S3d
	25	95	60	90	100	65	95	90	28.5	S3d
	26	95	80	100	95	65	95	90	40.1	S3d
	27	75	80	90	100	65	95	90	30.0	S3td
	28	75	90	90	100	80	95	90	41.6	S3td
High piedmont	29	55	80	90	100	65	95	90	22.0	N1td
	30	75	80	100	100	65	95	90	33.3	S3td
	31	55	60	90	95	65	95	90	17.4	N1td
			Overall mean of Si						33.4	

Note:

S2: Moderately suitable   S3: Marginally suitable   N1: Current not suitable

Si: Capability index   t: Texture   d: Drainage

TABLE 7. Suitability of soil profiles for drip irrigation system in the study area

Unit	Profile	Texture	Depth		EC	Drainage	Slope	Gypsum	Si	class
Coarse valley inner	1	95	100	80	100	100	100	100	76.0	S1c
	2	95	100	80	100	100	100	100	76.0	S1c
	3	95	90	80	100	80	100	100	54.7	S2dc
	4	95	100	80	100	100	100	100	76.0	S1c
	5	95	100	80	95	100	100	100	72.2	S2c
	6	95	90	80	100	80	100	100	54.7	S2cd
Coarse valley outer	7	90	70	95	100	65	100	100	38.9	S3d
	8	90	70	80	95	65	100	100	31.1	S3d
	9	95	90	95	100	80	100	100	65.0	S2d
	10	85	70	95	100	65	100	100	36.7	S3d
	11	85	70	80	100	65	100	100	30.9	S3d
Alluvial plain	12	95	100	80	100	90	100	100	68.4	S2c
	13	95	70	60	100	65	100	100	25.9	S3c
	14	95	100	80	95	100	100	100	72.2	S2c
Coastal plain	15	95	70	95	100	65	100	100	41.1	S3d
	16	85	70	95	100	65	100	100	36.7	S3d
Escarpment	17	95	70	95	100	65	100	100	41.1	S3d
	18	85	70	95	100	65	100	100	36.7	S3d
Sloping area	19	85	70	80	100	65	100	100	30.9	S3d
	20	95	90	80	100	80	100	100	54.7	S2c
Low piedmont	21	95	90	95	95	80	100	100	61.7	S2c
	22	95	70	60	100	65	100	100	25.9	S3c
	23	95	70	95	100	65	100	100	41.1	S3c
Moderately high piedmont	24	95	90	80	95	80	100	100	52.0	S2c
	25	95	70	80	100	65	100	100	34.6	S3cd
	26	95	90	80	100	80	100	100	54.7	S2d
	27	95	90	80	100	80	100	100	54.7	S2d
	28	95	100	80	100	90	100	100	68.4	S2c
High piedmont	29	85	90	95	100	80	100	100	58.1	S2t
	30	95	90	80	100	80	100	100	54.7	S2c
	31	85	70	80	100	65	100	100	30.9	S3d
			Overall mean of Si						50.3	

Note:

S1: Highly suitable S2: Moderately suitable S3: Marginally suitable

Si: Capability index t: Texture c: Calcium carbonate

d: Drainage

TABLE 8. Suitability classes areas for surface and drip irrigation systems

Suitability class	Area of Surface irrigation		Area of Drip irrigation	
	Km²	%	Km²	%
Highly suitable	0.0	0.0	5.8	2.1
Moderately suitable	14.6	5.3	153.9	55.7
Marginally suitable	177.4	64.2	116.6	42.2
Current not suitable	84.3	30.5	0.0	0.0
Total	276.4	100	276.4	100

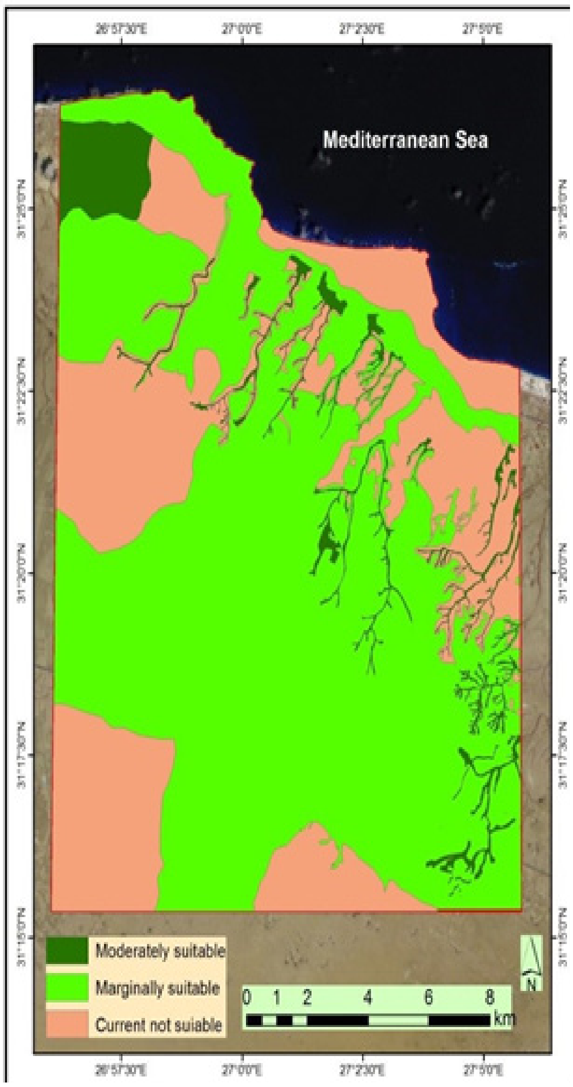

Fig. 6. Suitability classes map for surface irrigation system

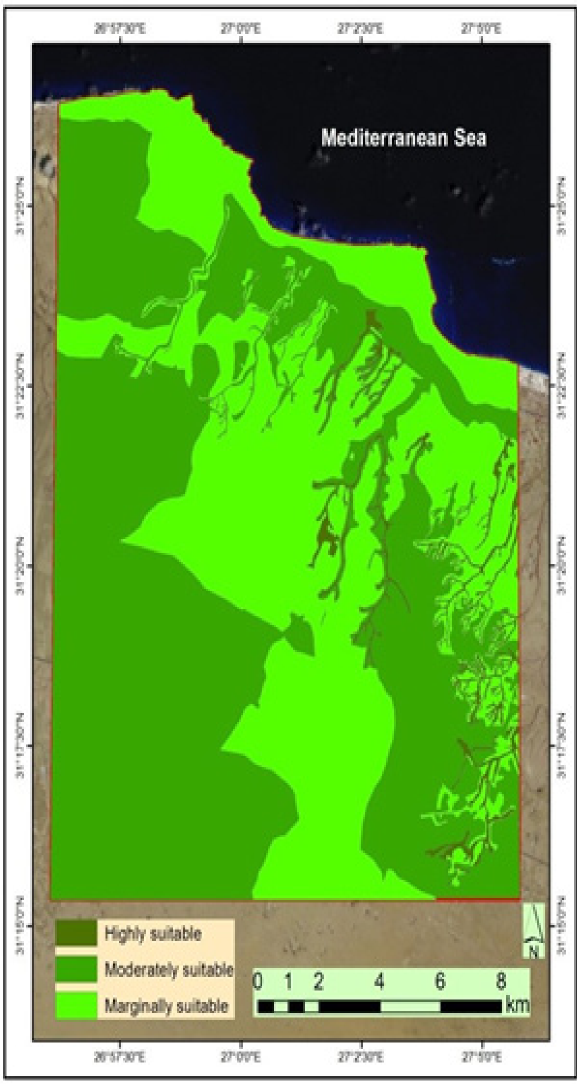

Fig. 7. Suitability classes map for drip irrigation system

Land suitability for drip irrigation system

Land suitability indices and classes for drip irrigation system presented in Table 7 and Fig. 7 indicated that, most of the studied soils (55.7 %) are considered as moderately suitable (S2) for this system including about 153.9 km^2(Table, 8).Also, a great soil portion (42.2 %) is affiliated to marginally suitable (S3) class (116.6 km^2), and very small area (2.1 %) are regarded as highly suitability (S1).The overall mean of land suitability index (Si) for the drip irrigation system in the studied area soils is 50.3.The main limiting factors to this system is mainly light soil texture and high $CaCO_3$ content.

Conclusions

This study achieved to produce a land suitability evaluation for specific irrigation systems at a part of west Matrouh area, northwestern coast of Egypt. Based on parametric approaches, land suitability for area was classified into S2, S3 and N1 classes covering an area 14.6m177.4 and 84.3km^2 respectively for surface irrigation system, whilein drip system moderately suitable (S2) increased to 153.9 km^2 and current not suitable (N1) not found, marginally suitable (S3) decreased to 116.6 km^{2}revealing that the drip irrigation is more benefit than the surface irrigation in this area. Drip irrigation system is very important way for water management toovercoming the water shortage problem in Egypt, where overall mean of land suitability for drip irrigation is 50.3 compared to surface irrigation which amounted only to 33.4

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القدرة الانتاجية للتربة تحت نظام الرى السطحى والتنقيط بالساحل الشمالى الغربى-مصر

إضافة مناطق زراعية جديدة خارج دلتا وادي النيل أحد الجوانب الرئيسية والاستراتيجيه المصريه لتوفير الغذاء ومواجهة الزيادة السكانية. المنطقة الساحلية الشمالية الغربية تم اختيارها لخصائصها لتوافر الموارد الارضية وكمية الأمطار المناسبة.

تهدف هذه الدراسة إلى تقييم القدرةالانتاجية لمنطقة الدراسة شمال غرب مصر مع التركيز على منطقة غرب مطروح. تم استخدام نموذج ارتفاع رقمي (DEM) لإنشاء الوحدات الفيزيوجرافية للمنطقة المدروسة. تم اختيار واحد وثلاثون قطاعًا تربة لتمثيل وحدة خرائط التربة. تم دمج قاعدة بيانات التربة مع موقعها المكاني والخرائط المختلفة التي تم إنشاؤها باستخدام Arc-GIS 10.9. باستخدام الاستشعار عن بعد وتحليل الصور باستخدام ERDAS imagine .أظهرت النتائج أن المنطقة المدروسة تشمل تسعة وحدات فيزيوجرافية مختلفة .

تحت نظام الري السطحي تم تصنيف التربة المدروسة إلى ثلاث فئات : (S2) متوسطة الصلاحية (٥,٣٪) ، (S3) هامشية الصلاحية (٦٤,٢٪) و (N1) غير صالحة تحت الظروف الحالية (٣٠٪). العوامل الأكثر تحديدًا لتقييم قدرة الأرض هي القوام وعمق التربة والصرف وزيادة محتوى كربونات الكالسيوم. تحت نظام الري بالتنقيط اوضحت النتائج ان ٢٪ من المساحة عالية الصلاحية ، 56٪ متوسطة لصلاحية و ٤٢٪ هامشية الصلاحية. الري بالتنقيط أكثر فائدة من الري السطحي ، حيث يعمل على تعظيم الاستفادة من وجدة التربة حيث كان متوسط مؤشر قدرة الأرض (Ci) لأنظمة الري السطحي والتنقيط ٥٠،٣٣. على التوالي.تحويل الرى إلى نظام بالتنقيط له العديد من المزايا اهمها توفير المياه ، أكثر من ٥٠٪ زيادة فى الانتاج.