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ORIGINAL ARTICLES

Land Resources Assessment for Agricultural Use in Some Areas West of Nile Valley, Egypt

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ABSTRACT

Due to constant decrease in agricultural lands, it is important to identify the best lands useful for sustainable agriculture development and protects the environment and that is socially equitable. The main objective of this study was to discuss the efficiency of agricultural land evaluation for assessing land use types in rural areas. In this research, the area west of Nile Delta that extends from Biba to Bani Mazar districts was selected as a case study site, which considers one of the high priority regions for future development in Egypt. As input, a total of fourteen representative soil profiles and number of observations points were used for collecting soil samples. Based on the ground truth data, laboratory analysis and imagery interpretation in cooperation with geographic information system (GIS) utilities, the physiographic map was generated. Three main physiographic units were identified as follow i.e. flood plain, desert plain and interference zone. The soils were classified mainly as Typic Torrifluvents, Vertic Torrifluvents, Typic Torriorthents, Typic Torripsamments and Typic Haplosalids. Land suitability assessment was done to define the suitable areas for agricultural production using ALESarid-GIS system and MicroLEIS microcomputer program as well. According to the crop suitability results, the most suitable crops to grow in the study area were Wheat, Barley, Sunflower, Rice, Peanut, Cotton, Sugarcane as high suitable crops in the flood plain mapping unit. In the interference zone and desert plain units the most recommended crops are sugar beet, tomato, date palm, cabbage, wheat, sunflower, fig, olive potato and pea. Generally, the data on land suitability resulting from the evaluation models indicated that 25.3 % of the study area is considered as suitable for most evaluated crops, 13.7 % is moderately suitable, 38.1 % is marginally suitable and 22.9 % is not suitable. The main limitation factors for land suitability are the excess of salts, shallow soil depth, inadequate drainage conditions, sodium saturation and poor soil fertility.

Key words: Agricultural land suitability, Optimal land use, ALESarid-GIS, MicroLEIS, Western desert.

Introduction

The total area of Egypt is around one million square kilometers. Approximately 93% of population lives on only 6% of the land. Nevertheless, overpopulation rates increase annually with more than 2.1 %, which is considered being one of the sustainable development impediments. Therefore, the policy of horizontal expansion represents a great importance for the development challenges. Since the 1980s, the Egyptian government has advocated policies aimed at extending cultivated land and maximizing production of the existing agricultural lands (Shalaby & Tateishi, 2007). Thus, Agro-ecological innovations are necessary to develop a new and truly reverse environmental deterioration, augment the supply of food and for the development rational land use policy (Uphoff 2002). According to the agro-ecological potentialities, a particular agricultural use plus proper land management system are considered the most appropriate tools to achieve sustainability (FAO 1978).

In this research, the area under investigation is located to the west of the Nile Valley and extends from Biba to Bani Mazar districts (Figure 1). It considered as one of the proposed areas for horizontal expansion policy and sustainable agricultural development. In this area, the river Nile is the main source of irrigation for the alluvial plain soils, while Bahr Yousef canal irrigated the desert plain soils. This situation provides sustained irrigation water in the investigated area (El Semary 2012).

The main target of land suitability assessment is to determine the ability of a piece of land to provide the optimal ecological requirements for a specific land use type. Indeed, assessing the capability of land is enabling optimum crop development and maximum agricultural productivity (Voncir *et al*. 2006; Ande2011). In principle, the known physical suitability evaluation emphasizes more to the physical properties than economic conditions. It indicates the degree of suitability for a particular land use type (Rossiter and van Wambeke 1997).

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There are many computer models and packages for simulating the land evaluation applications for land utilization planning (FAO 1993).

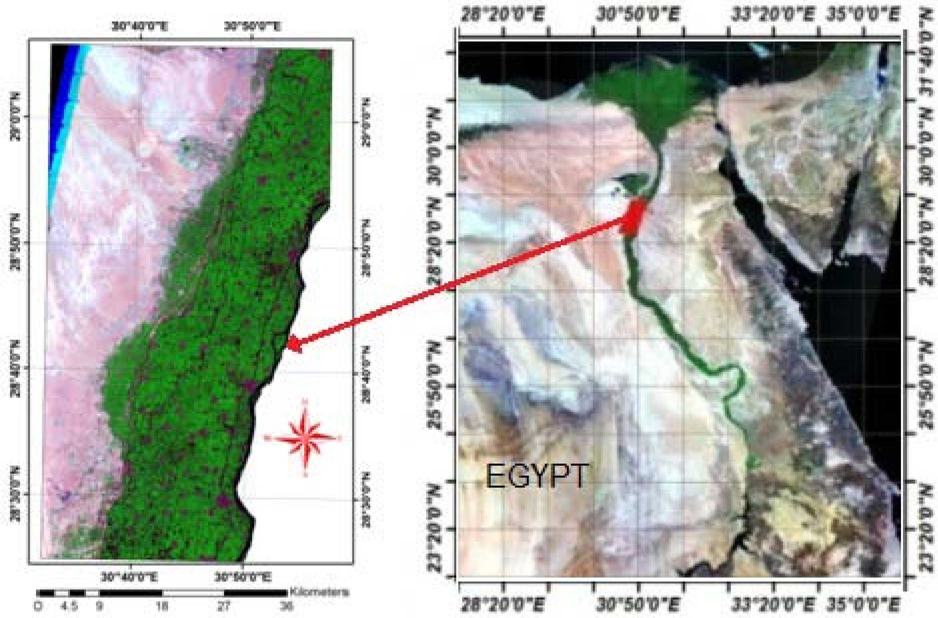

Fig. 1: Location of the studied area.

Since 1998, MicroLEIS Decision support system has considered a well-suited model and has evolved significantly towards an interface user-friendly agro-ecological system for sustainable land management (De la Rosa *et al*. 2004). All the main components of this Web-based decision support system and software are available free of charge from the URL www.microles.com. Lastly, it has been used as a useful considerable tool in evaluating selected areas for agricultural purpose. Darwish *et al*. (2006) evaluated the soils of Farafra oasis, Western desert, Egypt using MicroLEIS program. Their output data did demonstrate that most of Typic Haplogypsids soil map units were highly suitable for wheat, potato, and sunflower crops, while the rest showed low suitability.

MicroLEIS model has been used to predict the effect of water table and salinity on the productivity of wheat in sugar beet area, west Nubaria, Egypt (Bahnassy *et al*. 2001). The results reported that the productivity of wheat crop will decrease due to increasing salinity and shallow water table, as a result of mismanagement practices. Salem *et al*. (2008) found that the soils of El-Bostan, El-Nubariya region, can be diagnosed into highly suitable, moderately one and not suitable with respect to soil texture and the exchangeable sodium percent (ESP).

Meanwhile, to evaluate the soil suitability of Banagar ElSokkar area, Egypt, for some specific crops, MicroLEIS land suitability system has been implemented too (Yehia 1998). In Yehia's research, he reported that the main limiting factors were soil properties and land topographic conditions. In addition, MicroLEIS DSS system was used before to determine the soil suitability of Wadi El-Rayan depression, Egypt (Aldabaa *et al*. 2010). The system indicated low suitability in regard to the examined crops due to one or more limiting factors (mainly soil salinity). The MicroLEIS DSS models are described in detail by De la Rosa (1979), De la Rosa *et al*. (1981, 1992, 1993, 1999), Farroni *et al*. (2002), Horn *et al*. (2002), and Sanchez *et al*. (1982).

On the other hand, The Agriculture Land Evaluation System for arid and semi-arid regions ALESarid-GIS, has been developed by Ismail *et al*. (2005) to estimate the agriculture land evaluation. ALES arid is linked directly to its relational database and coupled indirectly with a Geographic Information System GIS through the loosely coupled strategy. ALESarid-GIS model was used before to decide the best agricultural land use in the western part of Nile Delta (Abd El-Kawy *et al*. 2010). With respect to cultivation, it is found that the land capability assessment indicated that 3.96 % of the total area is assigned as fair, 68.46 % is poor and 27.58 % is very poor as a result of low soil fertility. It is showed that the most suitable crops to grow were alfalfa, barley, wheat, sugar beet, onion, and pear.

Satellite remote sensing offers the opportunity to assess the effects of these processes and provide the data needed for the development of national agricultural strategies (Pax Lenney *et al*., 1996).

In this study, Almagra model constituent of MicroLEIS DSS (De la Rosa 2008) and the Agricultural Land Evaluation System ALESarid-GIS were used in order to assess and analysis the agricultural land suitability for land use planning. Both systems were selected to stand on the main factors that affect soil suitability and productivity. The output results were a matter of comparison and exported to a tubular platform.

This research mainly aimed to determine the common land characteristics in the western side of the Nile Valley and extends from Biba to Bani Mazar areas in order to evaluate soils for agricultural land suitability and crop diversification to achieve the agriculture development using two evaluation systems. These models are used for sustainable agricultural and assessing the main land use limitations that affect land productivity. Emphasis is given to the achievements made in passing from a land evaluation to a land resources information system, and in the beginnings of a decision support system. Meanwhile, the research investigates new reclaimed areas plus the cultivated ones in the Western desert region with the aim of producing the best agriculture land use.

Materials and Methods

Description of study area:

The selected study area is located to the west of the Nile Valley and extends from Biba to Bani Mazar districts at the south. It is bounded by longitudes 30° 32' 07" - 30° 57' 15" East; and latitudes 28° 24' 54" - 29° 05' 23" North. The Eastern border is limited by the river Nile, while the Western one extends about 10-15 km west of the Western desert road, where its main accessibility way. It covers an area of approximately (2704 km^2), where exhibit the old cultivation (1235 km^2) and arable land (1469 km^2) in the desert deposits (Fig. 1). Said (1993) mentioned that in the western side of the Nile valley, the middle Eocene formations are covered by Oligocene gravels and cobbles. The Eocene limestone may crop to the surface locally. The main geological deposits in the study area are Nile deposits, sand dunes, Aeolian deposits, gravels and basalt (CONOCO 1987). According to Abu El-Izz (2000) the studied area is built of the sediments of recent alluvium, Pleistocene, and Pliocene periods. The area under investigation falls under the arid condition as the total rainfall is (4-7.8) mm/year. The dryness is prevailing most of the year and the wet periods are comparatively short. Based on the Egyptian Meteorological Authority (2000-2009) data and Soil Taxonomy System (USDA, 2010), the soil temperature regime of the studied area is defined as Thermic, and the soil moisture regime as Torric. River Nile is the main source of irrigation water in the study area, where dense network of irrigation canals were distributed to for the fertile soils in the flood plain. It also characterized by a good drainage network. For the recently cultivated areas west of the study area Bahr Yousef canal is the main source for irrigation with condensed surface drainage network.

The fieldwork and laboratory analyses:

During the fieldwork, fourteen representative soil profiles and number of auger observations were taken to represent the delineated mapping units. The profiles' morphological description was carried out according to the guidelines outlined by FAO (2006). Laboratory analyses were done following the USDA soil survey laboratory methods manual (2004).

Geomorphology and soils mapping:

Nowadays, advanced techniques such as Geographic Information System GIS and remote sensing image analysis contribute to the accelerate and efficiency of overall planning process. In addition, such programs allow access to large amounts of information quickly (Hinton 1996; Dengiz 2007; Salim *et al*. 2008). Landsat 7 ETM+ image acquired in year 2011 (path 176 /row 40) was used to generat a geomorphologic map for the study area, which was done using digital image processing (Fig. 2). This image was executed using ENVI 4.7 software (ITT, 2009). Digital elevation model (DEM) of the studied area is used for driven physiographic map of the study area. Satellite image was stretched using linear 2 %, smoothly filtered and their histograms were matched according to Lillesand and Kiefer (2007). The physiographic units and different landforms were initially determined and delineated from the satellite image and the digital elevation model DEM extracted from STRM data, following the methodology developed by Dobos *et al*. (2002) (Fig. 2). The physiographic units were classified according to their landscape, relief, lithology, landforms and soil (Zinck and Valenzuala, 1990). The produced mapping unit boundaries have been checked during the field work, ground truth observations and the data extracted. ArcGIS 9.3 utility and its spatial analyst extension (ESRI, 2009) were used for mapping soil variables and land suitability mapping.

Land suitability assessment:

The suitability method was based on an analysis of soil characteristics, which influence the productive growth of 12 traditional Mediterranean crops by using ALMAGRA microcomputer program that built in MicroLEIS system. It matches soil characteristics of the soil units with growth requirements of each particular crop. In this study, five traditional crops are considered as follows: wheat, potato, and sunflower as annuals; alfalfa (Af) as semiannual; and citrus fruits as perennials. These crops were selected to be evaluated based on available soil conditions of the area under investigation. Integrating MicroLEIS Decision Support System DSS with GIS system for mapping and analysis allows the use of spatial techniques to expand land evaluation results from point to geo-referenced map units (De la Rosa *et al*. 2002). Depending on the gradations considered for each of the criteria selected (gradation matrices) and on the different agricultural uses, five suitability classes are established. Following the criterion of maximum limitation, the five suitability classes for each crop are (S1, S2, S3, S4, and S5) that are going from optimum, high, moderate, marginal, and no suitability and overlaid to produce the final land suitability based on the most limiting factor (Rota *et al*. 2006).

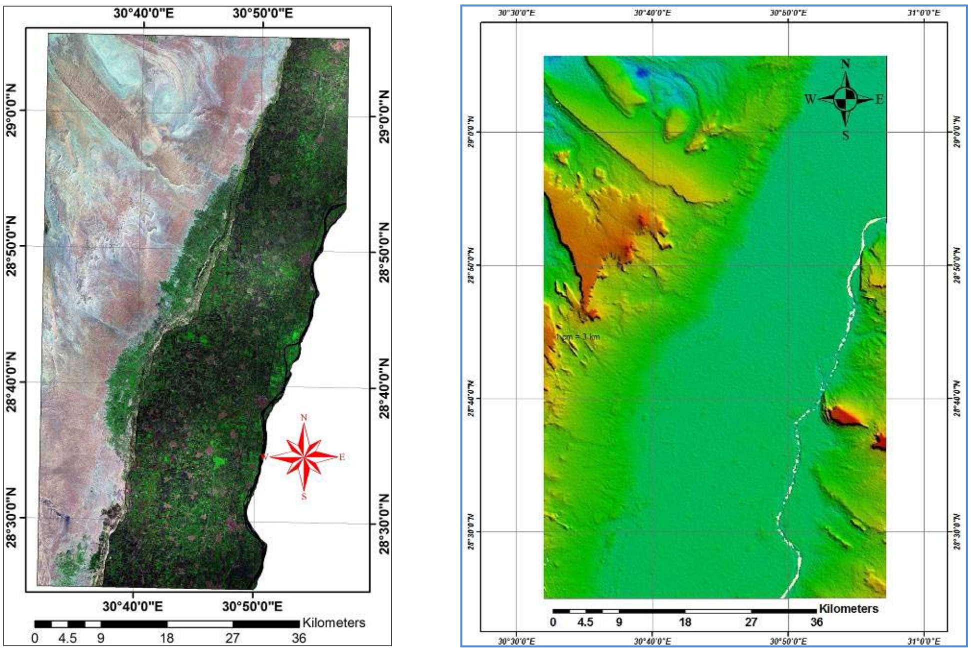

Fig. 2: Landsat ETM+ (left) and Digital Elevation Model DEM of the study area (right).

On the other hand, ALESarid-GIS evaluation model was used in this research to assess land suitability and come to a comparison conclusion. This system stands for Agriculture Land Evaluation System ALES for arid and semi-arid regions and been developed by Ismail *et al*. (2005). The main objective of land resources assessment for agriculture is to predict future conditions after development has taken place. It is necessary to forecast the benefits to farmers and the national economy and whether these will be sustained. The land suitability for 27 crops representing the main crops in Egypt was carried out using the ALES-arid software. The main data input used for this software includes the following parameters:

Water characteristics; Electrical Conductivity (dS/m), adj. SAR, pH, Na (meq/L), Cl (meq/L), Mg (meq/L), HCO_3 (meq/L) and Boron (ppm).

Soil properties; Soil texture (Clay %), structure (Class), depth (cm), slope (%), CaCO3 (%), ESP, EC (dS/m) and CEC (meq/100 g. soil).

Fertility status; Organic matter (%), Nitrogen (ppm), Phosphorus (ppm) and Potassium (ppm).

Environmental setting; Climate, geographical location, irrigation and drainage systems, dominant crops and communication status.

The suitability indices, classes and limitations were calculated according to the matching between standard crop requirements and various soil parameter levels (FAO 1979; Ismail *et al*., 2001). Nevertheless, ALES arid is considered as strong and efficient application within land use planning, habitat analysis, etc. In addition, it can be coupled directly to its relational database and linked indirectly with a GIS through the loosely coupled strategy (Ismail *et al*., 2005).

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Results:

Study area’s physiographic:

The dominant geomorphic features were delineated based on the Enhanced ETM+ satellite image, acquizied DEM, ground truth data and geological formations covering the study area. Accordingly, satellite images interpretation indicated that the study area includes three main physiographic units, namely:

1. **Flood plain (F).**
2. **Interference zone (I).**
3. **Desert plain (D).**

The produced map was imported into a Geo- database as a base map (Figure 3) and Table (1).

Soil of flood plain (F):

Soils of flood plain landscape represents 43.62% of the study area with an area of about 1137.06 km^2. It includes the river levee landforms close to the river Nile with an elevation 23m to 26 m (a.s.l.). It divides into high levee (32.38 km^2) and low levee (14.23 km^2). Besides, the river terraces of various elevations (30 – 35 m above sea level a.s.l.) occupy several locations of the flood plain. Topographically, the river terraces divided into; low, moderate and high terraces with areas of 229.34, 91.76 and 138.06 km^2 respectively. Nevertheless, Basins are considered dominant landform in the flood plain and occupying an area of 631.19 km^2 (i.e. 23.34 %). It includes overflow and decantation basins with areas of 193.91 and 437.21 km^2 respectively.

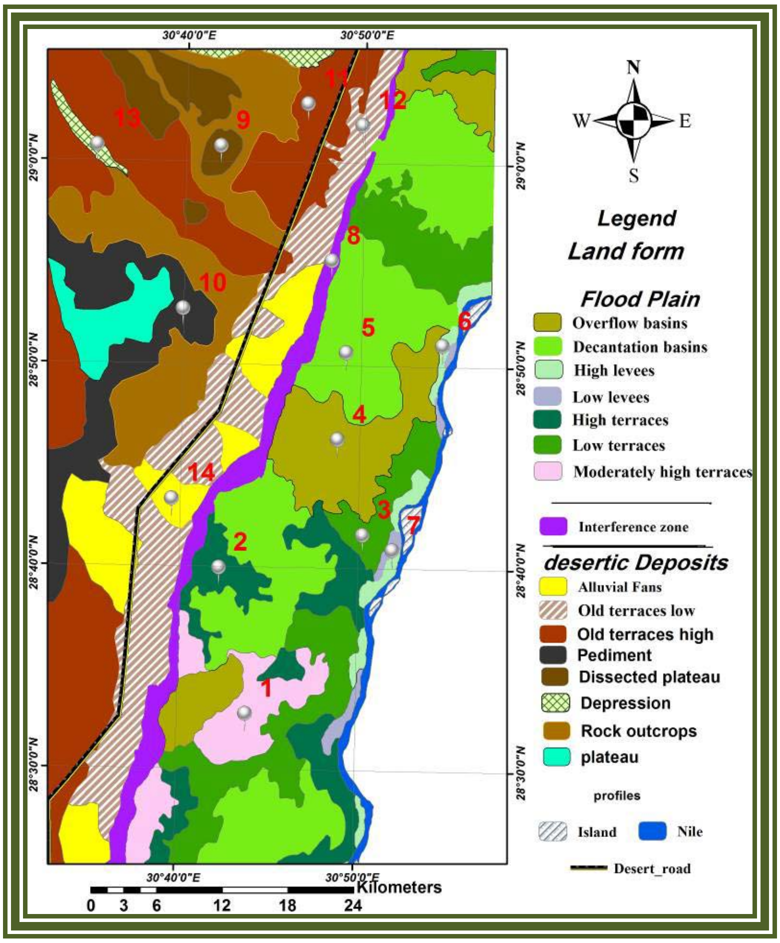

Fig. 3: Physiographic units of the area under investigation.

Interference zone (I):

This landscape occupies an area of 98.78 km^2, which represents 3.65% of the study area. It exist between the desert and flood plain landforms. In the area under investigation, the interference zone’s surface elevation changes from 40 to 45 m (a.s.l.).

Desert plain (D):

The desert plain is distinguished into the following landforms sequence; alluvial fans (141.25 km^2), depression (24.35 km^2), dissected plateau (70.15 km^2), high old terraces (465.63 km^2), low old terraces (261.30 km^2), pediment (153.08 km^2), plateau (53.14 km^2) and rock outcrops (257.34 km^2). This desert plain landscape dominates an area of 1426.24 km^2. The surface elevation of it is significantly increased from the east to west direction. Nevertheless, the elevation level differ from landform to another, where it closed to 50 m in alluvial fans, 52 m for the depression, 85 m for the dissected plateau, 70 m for the high old terraces, 55 m for the low old terraces. Concerning the pediment, rock outcrops and plateau the surface elevation reached 105, 135 and 239 m a.s.l. respectively.

Table 1: Legend of physiographic map of the study area.

landscape	Origin	Relief	Land forms	Mapping unit	Area (km^2)	Area (%)
Flood plain (F)	Alluvial deposits (1)	Gently undulating (1)	High terraces (1)	Ft111	138.06	5.11
			Moderately high terraces (2)	Ft112	91.76	3.39
			Low terraces (3)	Ft113	229.34	8.48
		Gently slope (2)	Overflow basins (1)	Fb121	193.91	7.17
			Decantation basins (2)	Fb122	437.28	16.17
			High levees (1)	Fl121	32.38	1.20
			Low levees (2)	Fl122	14.23	0.53
Interferences Zone (I)	Aeolian/ alluvial deposits (2)	Gently undulating (1)	Interference zone (1)	Ii211	98.78	3.65
Desert plain (D)	Aeolian/ deposits (3)	Gently undulating (1)	Old terraces high (1)	Dt311	465.63	17.22
			Old terraces low (2)	Dt322	261.30	9.66
		Undulating (3)	Pediment (1)	Dp331	153.08	5.66
	Aeolian/ alluvial deposits (2)	Hilly (4)	Dissected plateau (1)	Du241	70.15	2.59
		Gently undulating (1)	Depression (1)	Dd211	24.35	0.90
			Alluvial fans (1)	Df211	141.25	5.22
Total					2351.49	86.4
Plateau					53.14	1.97
Rock outcrops					257.34	9.52
Island					10.25	0.38
Nile					32.16	1.19

Soil classification:

According to the field work, laboratory analyses, and Keys to Soil Taxonomy (USDA 2010), the soil of the identified mapping units could be classified. The soils were classified mainly as Typic Torrifluvents, Vertic Torrifluvents, Typic Torriorthents, Typic Torripsamments and Typic Haplosalids.

Discussion:

Agricultural land suitability using MicroLEIS:

The agricultural suitability generated by the computer program MicroLEIS is presented in Table 2. It includes the soil suitability classes for the selected crops and limitations. All the fourteen soil profiles were evaluated for their agricultural suitability using ALMAGRA model, which is built in MicroLEIS system for agriculture land evaluation.

Out of fourteen investigated soil points, the map unit Ft111 (high river terraces) showed suitability (S2) for most evaluated crops. The map units Ft112 and Fl121 (moderate river terraces and low river levee) showed suitable to moderately suitable (S2– S3) with soil salinity and texture constraints to peach, citrus, and olive plantations. Besides, the map unit Fb121 (Overflow basins) illustrated almost moderate suitability (S3) except corn crop that show sodium saturation limitation. However, with the exceptional of peach, citrus, and olive results, the map units Fl121 and Df211 showed moderate to marginal suitability (S3–S4) with sodium saturation and texture limitations to most crops. Partly, map unit Du241 illustrated moderate suitability to most crops except; peach, citrus, and olive cultivations, it show marginal suitability (S4) due to soil salinity problems that combined shallow depth and bad drainage conditions. Nevertheless, The Fb122, Ii211, Dt322 and Dd211map units showed no suitable (S5) to almost all provided land use types. The Ft113, Dp331 and Dt311 map units demonstrated no suitable (S5) at all introduced crops as land use types of in respect to soil salinity and sodium saturation limiting factors. Soil sandy texture is reported also as a limiting factor for surface irrigation (Albaji *et al*. 2008).

Table 2: Agricultural land suitability for some crops using MicroLEIS system.

Landform map unit	Wheat	Corn	Melon	Potato	Soje	Cotton	Sunflower	Sugerb	Alfalfa	Peach	Citrus	Olive
High terraces (Ft111)	2	3	3	2	2	2	2	2	2	4 t	4 t	4 t
Moderately high terraces (Ft112)	3	3	3	3	3	2	3	2	3	4 ts	4 ts	4 t
Low terraces (Ft113)	5 sa	5 sa	5 sa	5 sa	5 sa	5 a	5 sa	5 a	5 a	5 sa	5 sa	5 sa
Overflow basins (Fb121)	3	4 a	3	3	3	3	3	3	3	3	3	3
Decantation basins (Fb122)	5 s	5 s	5 s	5 s	5 s	4 s	5 s	4 s	4 s	5 s	5 s	5 s
High levee (Fl121)	4 a	5 a	4 a	4 a	4 a	4 a	4 a	4 a	4 a	4 t a	4 t a	4 t a
Low levee (Fl122)	3	3	3	3	3	2	3	2	3	4 s	4 s	3
Interference zone (Ii211)	5 s	5 s	5 s	5 s	5 s	4 s	5 s	4 s	4 s	5 s	5 s	5 s
Dissected plateau (Du241)	3	3	3	3	3	3	3	3	3	4 pds	4 pds	4 pds
Pediment (Dp331)	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s
Old terraces high (Dt311)	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s	5 s
Old terraces low (Dt322)	5 s	5 s	5 s	5 s	5 s	4 s	5 s	4 s	4 s	5 s	5 s	5 s
Depression (Dd211)	5 s	5 s	5 s	5 s	5 s	4 ts	5 s	4 ts	4 ts	5 s	5 s	5 s
Alluvial Fans (Df211)	4 t	4 t	4 t	4 t	4 t	4 t	4 t	4 t	4 t	4 s	4 s	3

Useful depth (p), Texture (t), Drainage (d), Salinity (s), Sodium Sat (a)
Limitations: 1=No; 2=Slight; 3=Moderate; 4=Severe; 5=Very severe.

Crop suitability classification using ALESarid-GIS land evaluation:

On the other hand, the system's procedure is based on the main factors affecting agricultural soil productivity in arid and semi-arid regions. The results of land suitability classes for each crop in the different land forms and their definitions were divided into five categories using ALESarid-GIS system are illustrated in Table 3. The selected crops for this study include the following:

Field crops; Wheat, Barley, Faba bean, Soya bean, Sunflower, Rice, Maize, Peanut, Cotton, Sugarcane. **Vegetables and Forage crops;** Onion, Cabbage, Pea, Potato, Tomato, Pepper, Alfalfa, Watermelon, Sorghum. **Fruit trees;** Citrus, Banana, Grape, Olive, Apple, Pear, Fig, Date palm. The requirements of the selected crops have been matched with the land characteristics in the different landforms.

The assessment of physical land suitability for the different land use types (LUT) has been conducted for the capable soil units using Automated Land Evaluation System, ALES, by implementing the FAO framework (Ali, 2008). The obtained data could be detailed in the following:

The flood plain includes the river terraces, basins, and levees. In the river terraces landform the high suitable crops (S1) is dominated in moderately high terraces. The soils of this landform include no limitation for the most of the selected crops. The crops of Fig, olive and grape showed moderately suitable (S3) in this landform. The marginally suitable crops (S4) include Pea, Onion, Maize, Pepper, Faba bean, Soya bean, Apple, Citrus, Watermelon and Potato. It is found that the Pear, Banana and Peanut are permanently not suitable (S5) due to the water table depth.

The data illustrated in Table (3) represent the suitability classes of the selected crops in the basins soils. The results indicate that the high suitable crops (S1 and S2) for Fb121 and Fb122. However, the (Fb122) map unit demonstrated moderately suitable crops (S3) i.e. Fig, Olive, Watermelon, Pea, Onion, Faba bean, Apple, Citrus and Peanut and marginally suitable crops (S4) i.e. Pear and Banana. The main limiting factors of the low suitability classes in these land forms are water table, Electrical conductivity (EC) and Exchange Sodium Percentage (ESP).

Table 3: The crop suitability of the different diagnosis landform mapping units.

Landform unit	Land Suitability Classes				
	S1	S2	S3	S4	S5
Moderately high terraces (Ft112)	T, B, G, R, Ca, Pe, Af, On, To	Ri, Fa, A, Gr, Pp, Me, Ba, Dp, Pn, Fi, Ap, Pr, O, P, So, M, Sc, C, S			
High terraces (Ft111)	Af, T, B, G, R, Ri, A, So, Sc, Ca	To, Dp, Pe, On, M, Fi, O, Gr, Ba, P, Fa, S, Ap, C, Pe, Pp, Me, Pn			
Low terraces (Ft113)	R, B, G	A, T, Ca, To, Dp, Af, Ri, Sc, So	Fi, O, Gr	Pe, On, M, Pp, Fa, S, Ap, C, Me	Pr, Ba, Pn
Overflow basins (Fb121)	R, Ca, To, G, T, B, Pe, On, Pp, A, Dp, Ri, So, M, Sc	Fa, Gr, Af, Me, Pn, Fi, Ap, Pr, O, P, C, S, Ba			
Decantation basins (Fb122)	Af, T, Ba, G, R, Ca, A, Ri	To, Dp, M, Pp, So, Sc, Gr, P, S	Fi, O, Me, Pe, On, Fa, Ap, C, Pn	Pr, Ba	
High levee (Fl121)	R, G, T, B, Ri, A, Af, Sc, Dp, Ca, To, So	Gr, Me, Fi, Ap, O, Pp, On, M, Sc, Pe, Ba, Fa, S	C, P, Pn, Pr		
Low levee (Fl122)	R, To, Dp, A, T, B, G	M, Ri, Ca, So, Sc, Af, Fi, O, Me, Gr, P	Pe, On, Fa, Ap, S, Pp	Pn	Pr, Ba, C
Interference zone (Ii211)	R, G, T, B, A, Af, Sc, Gr, Me, Dp, Fi, O, Ca, To, So	Ap, Pp, On, M, Sc, Pe	Fa, S, C, P	Pn, Pr, Ba	
Dissected plateau (Du241)		G, A, R, B	On, Ca, Af, To, Pp, T, Ri, So, Pe	Fa, P, Me, M, Sc, S, Dp	Gr, Ap, Fi, C, O, Pr, Ba, Pn
Pediment (Dp331)		A, G, R, B	Pe, On, Fa, Pp, Me, P, To, M, Ri, Ca, So, Af, T	Gr, Pn, S, Sc, Dp	Pr, Ba, C, Ap, Fi, O
Old terraces high(Dt311)		R, B, Sc, G, A	To, Pe, Ca, On, Pp, Af, Me, Ri, So, M, Fa, P	Gr, S, Dp, Fi, O	Ap, C, Pr, Ba, Pn
Old terraces low (Dt322)	R, To, Dp, M, Ca, So, A, T, G, B, Fi, O, Gr, Me, P, Pe, On, Fa, Pn, Pp	Sc, Af, Pr, Ba, C, S, Ap			
Depression (Dd211)	Dp, A, G, R, To, B	Fi, O, T, Ca, Gr, Af, Sc, So	Pp, On, Me, P, S, M, Ri, Fa, Ap, C	Pr, Ba, Pn	
Alluvial Fans (Df211)	Dp, A, G, R, So, Pp, To, Fi, O, B, T, Ca, Gr, Me	Af, Sc, Ri, M, P, Pe, On, S, Fa, Ap, C	Ba, Pr, Pn		

Crops: Wheat= T, Barley= B, Faba bean= Fa, Soya bean= S, Sunflower= G, Rice= Ri, Maize= M, Peanut= Pn, Cotton= A, Sugarcane= Sc, Sugerb= R.
Vegetables and Forage crops: Onion= On, Cabbage= Ca, Pea= Pe, Potato= P, Tomato= To, Pepper= Pp, Alfalfa= Af, Watermelon= Me, Sorghum= So.
Fruit trees: Citrus= C, Banana= B, Grape= Gr, Olive= O, Apple= Ap, Pear= Pr, Fig= Fi, Date palm= Dp.
S1= highly suitable, S2= suitable, S3= moderately suitable, S4= marginally suitable and S5= permanently non-suitable.

Table (3) represents the suitability classes of the river levees in the study area. The marginally suitable crops (S4) only include Peanut while the permanently not suitable (S5) are Pear, Banana and citrus. The low suitability classes are mostly related to the water table EC and ESP.

On the other hand, the suitability classes of the selected crops in interference zone landform. This landform includes four classes of crop suitability where high suitable crops (S1) include Sugar beet, Sunflower, Wheat, Barley, Rice, Cotton, Alfalfa, Sugarcane, Grape, Watermelon, Date palm, Fig, Olive, Cabbage , Tomato and Sorghum. Soil salinity and fertility are considered as the main limiting factor in this landform.

The suitability classes of the dissected plateau and pediment in the study area are considered here. The dissected plateau landform includes the four classes of crop suitability. It is found that soil depth, natural drainage, and salinity and poor fertility are the main limiting factors in these landforms.

Moreover, suitability classes of the high old terraces and low old terraces in the study area reported four classes of crop suitability. The low old terraces showed high suitability to Sugar beet, Tomato, Date palm, Maize, Rice, Cabbage, Sorghum, Cotton, Wheat, Sunflower, Barley, Fig, Olive, Grape, Watermelon, Potato, Pea, Onion, Fababean ,Peanut and Pepper. The main limiting factors in the high old river terraces for crop suitability are soil depth, salinity and fertility, while in the low old terraces the limiting factors are soil salinity and fertility.

The Depressions map unit includes the four classes of crop suitability where high suitable crops (S1) include Date palm, Cotton, Sunflower, Sugar beet, Tomato and Barley. The limitations of crop suitability in this landform are soil salinity and fertility. The suitability classes of the Alluvial fans in the study area include the three classes of crop suitability, where few limitations are found in this landform due to the low fertility status.

Generally, soil salinity is reported a major limiting parameter for crop suitability in this area. Soil salinity and salinity of irrigation water are considerable limiting parameters for onion plantation. It is found that soil salinity has a slight effect on wheat, nevertheless; salinity of irrigation water is considered a non-limiting parameter for it (Abd El-Kawy *et al*. 2010). Soil depth has a recognized effect on apple, citrus and olive suitability (Abdel Mottaleb, *et al*. 1997; El-Hemely 1992).

The potential soil suitability for crops depends upon the possibility of soil improvement and overcome the limiting factors. The suitability classes were based on the maximum limitations factors that cannot be corrected (Cardoso 1970).

Obviously, there are quite matching and overlapping incidences between the output results of MicroLEIS Almagra model and ALESarid-GIS system for agricultural land suitability that could summarized in Tables 2 and 3. There are quite matching between Ft111, Ft112, Fl122 and Fb121 mapping units. However, for (Du241) and (Dt322) mapping units show different results. In case of using MicrloLEIS, Dissected plateau (Du241) showed moderate suitability S3 and reported useful depth, drainage and salinity limitations with peach, citrus, and olive plantation. Old terraces low (Dt322) illustrated marginal suitability to completely no suitability with most evaluated crops. Nevertheless, by using ALESarid-GIS, it is found that (Du 241) reported no suitability with peach, citrus, and olive plants. In addition, (Dt322) map unit showed high suitability to most examined crops.

Normally, data of land suitability classes indicate that 25.33 % of the study area is suitable for the most evaluated crops, 13.68 % is moderately suitable, 38.12 % is marginally suitable and 22.87 % is not suitable.

ALESarid-GIS land suitability system is based on crop suitability affected by the environmental potential at the site, such as the soils physical, chemical, and fertility characteristics, irrigation water quality, and climatic conditions. ALESarid-GIS was designed to calculate land valuation based on both decision trees and maximum limitation tables.

Almagra model constituent of MicroLEIS system is matching the soil characteristics of soil map unit with growth requirements of each particular crop and results in the crop growth limitations being provided by the computer. The modeling phase involves the following main stages:

Selection of land attributes: land characteristics and associated land qualities; & Defining of relevant land use requirements or limitations: land use response or degradation level; & Matching of land attributes with land use requirements; and & Validation of the developed algorithms in other representative areas.

Remarkably, ALESarid-GIS system takes into consideration environmental factors, e.g., climatic data, geographical location, irrigation and drainage system, dominant crops and communication status that could play certain role in differentiate particular map units than MicroLEIS suitability method, which focus more on soil-inherent characteristics. This could be the reasons for unequal suitability classification decision for (Du241) and (Dt322) map units between the two implemented systems in this study.

Conclusion:

In principal, this study investigates and evaluates the land resources of some soils west of the Nile valley with the aim of producing optimum agriculture land use types. The produced agricultural land use could provide decision makers, stick holders and farmers with the information needed for improving land use systems and guide them as to what crops are mostly suitable for the area.

In general speaking, the land within the study area can be classified in three suitability classes (S2, suitable; S3/S4, moderate to marginally suitable; and S5, unsuitable). The suitability class S2 represents 25.33 % of the studied area and is mostly located in the flood plain.

The suitability classes are considered moderately suitable (S3) to marginally suitable (S4) for almost half of the study area for each selected crop.

The recommended crops of the study area are Wheat, Barley, Sunflower, Rice, Peanut, Cotton, Sugarcane as high suitable crops in the flood plain. In the interference zone and desert plain the most recommended crops are sugar beet, tomato, date palm, cabbage, wheat, sunflower, fig, olive potato and pea.

The main limiting factors in the flood plain soils are exchangeable sodium percentage and soil salinity. On the other hand, useful soil depth, soil texture, fertility and soil salinity are considered the main limiting factors in the soils of interference zone and desert plain. The general dominant limiting parameters affecting land suitability are soil salinity, shallow soil depth, and inadequate drainage conditions. The two major constraint factors limiting yield production in the studied area are soil salinity and alkalinity for wheat and clay content for

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maize. Nevertheless, salinity induced by human activities is the greatest problem throughout the study area. Salinity can be removed from these soils through applied leaching requirements, good irrigation water, and designed unique land management programs.

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