J. of Soil Sciences and Agricultural Engineering, Mansoura Univ.,Vol 10 (12):771-780, 2019

Journal of Soil Sciences and Agricultural Engineering

Journal homepage: www.jssae.mans.edu.eg
Available online at: www.jssae.journals.ekb.eg

Assessment of Land Degradation Risk in El-minufiya Governorate, Egypt

Heba S. A. Rashed*

Soil and Water Department, Faculty of Agriculture, Moshtohor, Benha University, Egypt.

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ABSTRACT

El-Minufiya Governorate represents the traditional agriculture in the Nile Delta of Egypt and includes old cultivated and newly reclaimed soils; it represents an area of 217160 ha. GIS and remote sensing are integrated to determine the risk of soil degradation in the studied area. Fifteen soil profiles have been described and collected samples. There were two landscapes: flood plain and aeolian plain. The main landforms are levees (L), overflow mantles (O), overflow basins (B1), decantation basins (B2), recent river terraces (R1 high, R2 moderate and R3 low), turtle backs (T) and sand sheets (S). Compaction (C), water logging (W), Salinization (S) and alkalinization (A), are the main degradation hazards in the studied area and the rate of hazards was low to very high. Soils affected by very high hazard of salinity represented 16.70%, of the total area. The very high hazard of compaction was present in 35.15% of the total area as a result of human activities, inadequate soil management, and using heavy machinery. Soils affected by a high hazard of salinity, compaction and water logging represented 14.66%, 3.60% and 20.50% of the total area, respectively. Moderate hazard of salinity, sodicity, compaction and water logging represented 36.50%, 33.70%, 34.00% and 79.50% of the total area, respectively. A simple model was used to estimate land degradation risk, based on an equation by FAO/UNEP model. A portion of 39.60% of area has a very high chemical degradation and low physical degradation risk in L, B2, R1 and R2 mapping units. The area of low chemical degradation and moderate physical degradation class is 17.00% of study area in T and S mapping units. The area of low physical and chemical degradation is 32.80% of study area in O, B1 and R3. Changes of land use/land cover classes during 1987 to 2018 indicate urban sprawl. Most of soils in the study area showed several categories of land use/land cover change due to agriculture activities and urban growth.

Keywords: Nile Delta, land degradation risk, urban sprawl and El-Minufiya Governorate.

INTRODUCTION

Lands are limited a resource, which provides essential support to ecosystems in the world for sustainable agriculture (Blum, 2006; Cronin, 2009; Jankava *et al*., 2017 and Saeed *et al*., 2018). Land is includes soil resources, plant, water, microorganisms, microorganisms, landscape, climate, and ecological systems (Moyo, 2000; MEA, 2005 and Vlek *et al*., 2008). The land meets three human needs: food, clothing, and shelter (Jankava *et al*., 2017). According to UNDP (2007), agriculture is the backbone of the economy in many countries; agricultural land is combines of natural ecology, social and economy (Jankava *et al*., 2017 and Scown *et al*., 2019). Agricultural land represents about 40 – 50 % of the world (Adams and Eswaran, 2000 and Davis and Masten, 2003). In Africa about 60% of the populations are dependent on agriculture (Moyo, 2000 and Vlek, 2005). In the Arab World Egypt is the most populous (FAO, 2015), most of its population lives near of the Nile River (Randolph, 2004; WB, 2007 and CAPMAS, 2009). In Egypt, soil degradation is a main constraint to development of agricultural (Abdel Kawy and Ali, 2012 and Khalil *et al*., 2014). In Egypt the main types of land degradation are salinity, sodicity, compaction and water logging (Randolph, 2004 and Darwish and Abdel Kawy, 2008). The oldest land in the world is the cultivated land of Nile Delta, Egypt (Shalaby, 2012). The causes of soil degradation in the Nile Delta of Egypt are human activities and uncontrolled urbanization (Eswaran *et al*., 2001).

In the world about 6 million ha of agriculture land becomes unproductive due to soil degradation processes (Asio *et al*., 2009). Land degradation decreases land capability and causes deterioration in soil productivity (FAO/UNEP, 1978; Berry, 2003; Bai *et al*., 2008; Pierre, 2010; El Baroudy, 2011; Gessesew, 2017 and Masoudi *et al*., 2018). Eswaran *et al*. (2001) stated that about 1360 million ha of land on the worldwide are moderately to severely degrade. Impacts of soil degradation on ecological function ultimately affect on quality of life (El Baroudy, 2011; Masoudi, 2014; Vu *et al*., 2014; El-Baroudy, 2015; Masoudi and Amiri, 2015; Rashed, 2016 and Sadeghi *et al.* 2017). Land degradation assessment is difficult because it includes several complex processes (Safriel, 2007; Bai etal., 2008; Jankava *et al*., 2017 and Masoudi *et al*., 2018).

According to Huang *et al.* (2015) about 40% of land degradation has occurred in developing countries of the worldwide. Land degradation threatens sustainable development, and is a serious problem for all sectors of human activities (Diamond, 2005; Reed and Stringer, 2016; Israr *et al*., 2017; Webb *et al*., 2017 and Zambon *et al*., 2017)). The risks of climate change to agriculture, biodiversity, and livelihoods are vast (IPCC, 2014 and Fava *et al*. 2016). The effects of land degradation and climate change have often been withheld by the rapid technological advances (Pingali, 2012). Land degradation

* **Corresponding author.**
E-mail address: heba.abdelmaabood@fagr.bu.edu.eg
DOI: 10.21608/jssae.2019.79575

risk can be estimated in many ways, such as field observation, RS and GIS (Gao and Liu, 2008). GIS and RS can investigate land degradation risk, monitor desertification and modeling soil loss (Lu *et al*., 2007; Mathieu *et al*., 2007 and Rangzan *et al*., 2008; Miehe *et al*., 2010; Higginbottom and Symeonakis, 2014 and Pinzon and Tucker, 2014).

The objectives of the present study are to: (1) produce a physiographic map of the area, (2) identify and evaluate land degradation risk using equations of FAO/UNEP (1978, 1979) and (3) assess the changes of land use/cover features.

MATERIALS AND METHODS

Study area

El-Minufiya Governorate represents the traditional cultivation in the Nile Delta, Egypt. It is located in the middle of the Nile Delta between latitudes 31° 5' and 31° 25' N, and longitudes 30° 10' and 30° 40' E, incorporating an area of 217160 ha (Figure 1). According to the aridity index classes (16), El-Minufiya Governorate is located under dry climatic conditions (CNE, 2006). According to ESIAF (2010) the total rainfalls about 2.4 mm/year and the mean minimum and maximum annual temperatures are 14.7 and 32.5 °C, respectively. The study area have Thermic temperature regime with Torric soil moisture regime. Elevations in this Governorate vary between 0 and 25 m above the mean sea level (a.m.s.l.). Land of El-Minufiya Governorate belongs to the late Pleistocene era (Hagag, 1994 and Said, 1993). The major geomorphic units in middle of Nile Delta, namely: young deltaic plain, old deltaic plain and young Aeolian plain (EI-Fayoumy, 1968).

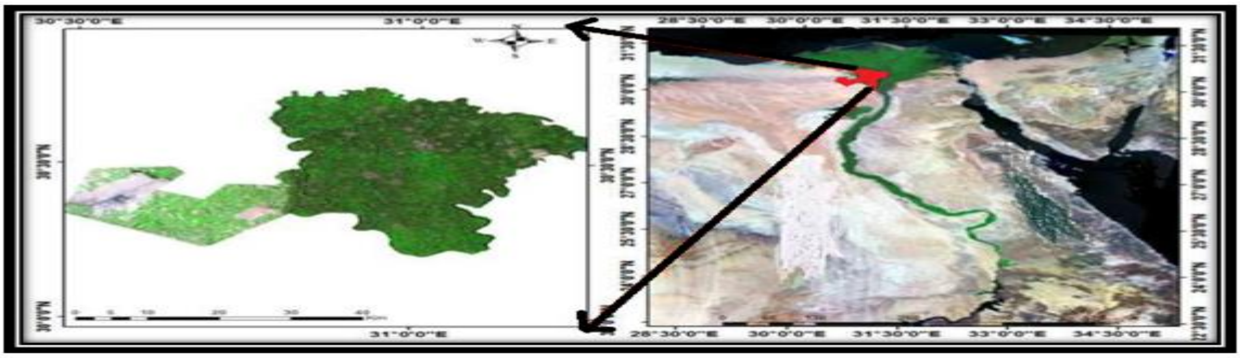

Figure 1. Location of El-Minufiya Governorate.

Physiography and soil mapping.

Two types of Landsat images: Landsat MSS (1987) and Landsat-8 ETM$^+$ (2018). To study changes in land use, vegetation cover and urban sprawl as indicators of land degradation were studied. Geomorphologic map was carried out using the Landsat-8 ETM$^+$ image taken during the year 2018, Path / Row: 177 / 44 were used in this study. The scenes were selected to be geometrically corrected by using EVNVI 5.1 software. ArcGIS, version 10.2 has been used as the main GIS software to evaluated land degradation processes.

Field work and laboratory analyses.

A semi detailed survey was done throughout the investigated area in order to gain an appreciation on the soil patterns, the land forms and land use/cover. The different mapping units were represented by 15 soil profiles, the morphological descriptions of the soil profiles were according to FAO (2006). The Soil taxonomy classification system, (USDA, 2014) was used to classify the soils. Representative soil samples were collected and analyzed using the soil survey laboratory methods manual (USDA, 2004 and Bandyopadhyay, 2007).

Land degradation assessment

FAO/UNEP (1978) criteria are used to determine the degree, class and rate that belong to land degradation as shown in Table 1. Degradation hazard was also estimated using the current values of physical parameters (bulk density & soil depth) and chemical parameters (EC & ESP).

Table 1. FAO/UNEP (1978) criteria of the different degradation hazard types.

Degradation hazard type	Indicator	Degree	Degradation hazard class			
			(1) Low	(2) Moderate	(3) High	(4) Very High
Salinization	EC	dS/m	<4	4-8	8-16	>16
Sodicity	ESP	%	<10	10-15	15-30	>30
Compaction	Bulk density	Mg/m^3	>1.6	1.4-1.6	1.2-1.4	<1.2
Waterlogging	Soil depth	Cm	>150	150-100	100-50	<50

Land degradation risk assessment.

A simple model for assessing the risk of land degradation based on the equations provided by FAO/UNEP (1978, 1979). This model was calculated risk of degradation based on soil, topography and climatic factors. The land degradation risk (LDR) was determined as follows equation:

$$\text{Land Degradation Risk (LDR)} = CR \times SR \times TR$$

Where: CR is the climatic rating, SR is the soil texture rating and TR is topographic rating.

RESULTS AND DISCUSSION

Geomorphologic- units of the studied area:

The main geomorphologic units in the study area can be divided into two landscapes as the followings:

- **Flood plain**: which represents 72.70 % of the total area; and includes landforms of river levees (L), overflow mantles (O), overflow basins (B1), decantation basins (B2), river terraces (R1, R2, & R3), and turtle backs (T). The soils are: Typic Torrifluvents and Vertic Torrifluvents sub great groups (Table 2 and Figure 2)..

- **Aeolian plain:** which represents ٢٥.٢0 % of the total area; and includes hummock areas (H) and sand sheets (S) and represents 25.20 % of the total area. The soils are: Typic Torripssamments (Table 2 and Figure 2).

Table 2. Landscape, landforms and mapping units and their areas total study area.

Landform	Mapping unit	Profile No.	Area (ha)	Area %	Soil Taxonomy
Nile River	NR	-	4456.00	2.10	_____
Landscape No. 1: Flood plain (Almost flat to gently undulating)					
Levees	L	1	1935.00	0.90	*Vertic Torrifluvents*
Overflow mantle	O	11 and 12	7821.00	3.60	*Vertic Torrifluvents*
Overflow basins	B1	2 and 3	44512.00	20.50	Typic *Torrifluvents*
Decantation basins	B2	4	19625.00	9.00	*Typic Torrifluvents*
High River terraces	R1	5, 6 and 7	31830.00	14.60	Typic *Torrifluvents*
Moderate River terraces	R2	8 and 9	32685.00	15.10	*Typic Torrifluvents*
Low River terraces	R3	10	18916.00	8.70	*Vertic Torrifluvents*
Turtle backs	T	13	642.00	0.30	Typic Torripsamments
Landscape No. 2: Aeolian plain (Gently undulating)					
Hummock areas	H	-	18483.00	8.50	Typic Torripsamments
Sand sheets	S	14 and 15	36255.00	16.70	Typic Torripsamments
Total area (ha)			217160.00	100.00	

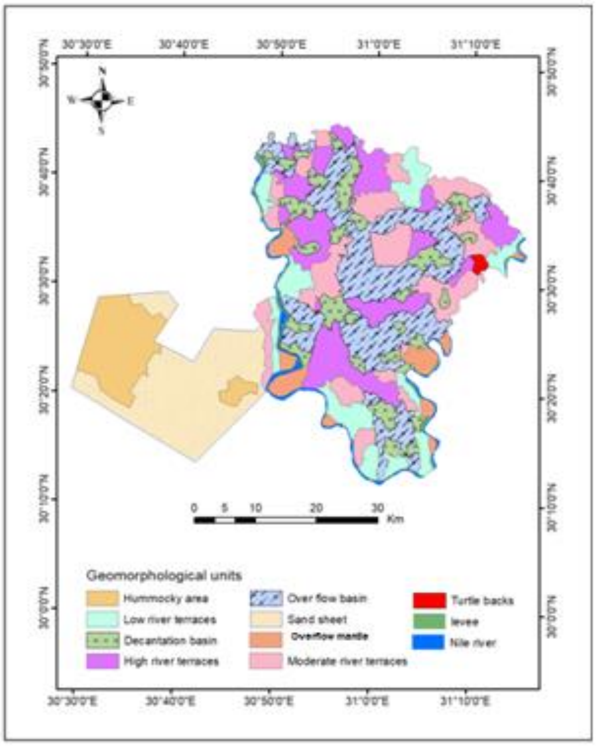

Figure 2. Geomorphologic map of the studied area. Change detection dynamics between 1987-2018.

The change of different features in the investigated areas during the period from 1987 to 2018 increased and decreased as a response to different activities such as urban encroachment over arable lands and reclamation of barren lands. Figures 3 and 4 show image of Landsat-MSS acquired in 1987 and image of Landsat-8 ETM+ in 2018.

Change detection in agricultural area and bare land in the investigated area from 1987 to 2018.

Area of agriculture land increased during the period of 1987 to 2018. In 1987 the 148030.96 ha become 171443.74 ha in 2018 increasing by 23412.78 ha. These results could be attributed to agriculture expansion on desert land. The area of bare land was 54738.00 ha in 1987 and become 16421.40 ha in 2018 decreasing by 38316.60 ha. Table 3 and Figure 5 show the change during the period of 1987 – 2018 in El-Minufiya Governorate.

Change detection in Urban sprawl in the investigated area from 1987 to 2018.

Urban growth caused serious losses of agricultural land in Egypt **(Hegazy and Kaloop, 2015).** Urban expansion in El-Minufiya Governorate during 1987 to 2018 was considerable (Figure 5). The impact of this urban expansion land was evaluated and the statistical data are illustrated in Table 3. Urban area increased from being 9935.04 ha in 1987 to 24838.86 ha in 2018 increasing by 14903.82 ha.

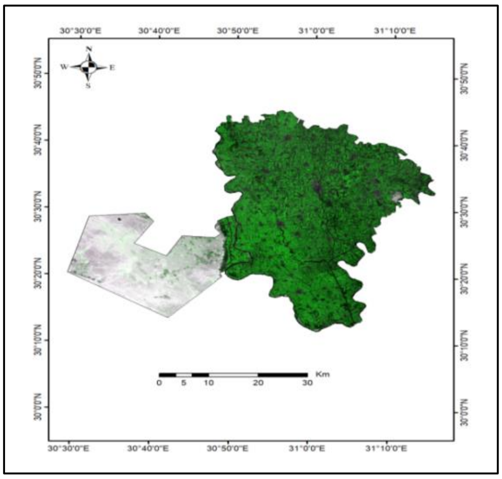

Figure 3. Land use/landcover features in 1987 of El-Menofiya Governorate (Landsat-MSS).

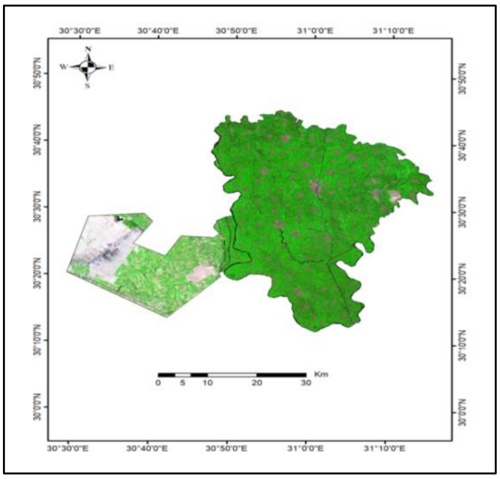

Figure 4. Land use/landcover features in 2018 of El-Menofiya Governorate (Landsat-8 ETM+).

Table 3. Changes in the areas of different soils and urban in El-Minufiya Governorate in 1987 and 2018.

Land type	Total area in 1987 (ha)	Total area in 2018 (ha)	Change (ha)
Agricultural area (arable land)	148030.96	171443.74	+23412.78
Bare land	54738.00	16421.40	-38316.60
Urban area	9935.04	24838.86	+14903.82
Water bodies	4456.00	4456.00	__0.00__

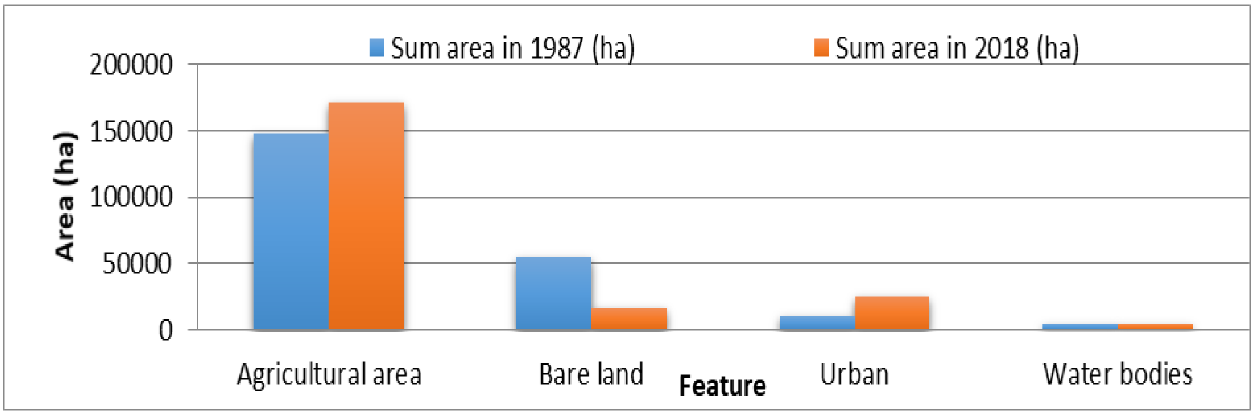

Figure 5. Change detection in land cover and urban area during the 1987 – 2018 in El-Minufiya Governorate.

Soil characteristics and degradation evidences of the studied area.

The weighted means of the soil characteristics of each mapping unit in the studied area are shown in Table 4. The results indicate that the soil depth, slope, texture, salinity, sodicity, bulk density and drainage condition of the study area range from 70 to 150 cm, 0.8 to 2.0 %, sand to clay, 0.88 to 21.56 dSm^{-1}, 2.74 to 13.01, 1.17 to 1.73 Mg/m^3 and poor to well, respectively. Salinization, alkalinization, water logging and compaction, are low to very high. Soils had a wide range of salinity with EC ranging from 0.88 to 21.56 dS m^{-1}. Low EC were in the soils irrigated with Nile water (0.88 to 7.54 dS m^{-1}), while values of >8 dS m^{-1} were in soils irrigated with ground water. Soils of O, B2, R3 and T mapping units had EC < 4 dS m^{-1} (non saline), while a range of 4 – 8 dS m^{-1} was in L, B1 and R2 units and more than 8 dS m^{-1} in R1 and S units. Results indicate that the soils ranged from non-sodic to sodic. Sodicity depended on the distribution of pH. Soil ESP in different mapping units ranged between 2.74 and 13.01. Soils of O, B1, B2, R1, R3 and T units recorded lower ESP < 10 (non sodic) and a range of 10 – 15 is recorded in L, R2 and S units (Table 4). Soil depth ranged between 70 and 150 cm. All soils depths were 100 – 150 cm, except for B1 unit which recorded soil depth < 100 cm (Table, 4). Soil compaction ranged between 1.17 and 1.73 g/cm^3. Soils of B1 and R1 units recorded < 1.2 g/cm^3. Soils of L, B2, R2, R3 and T units recorded 1.4 – 1.6 Mg/m^3. Soils of O soil mapping unit recorded soil compaction a range of 1.2 – 1.4 Mg/m^3, while soils of S unit recorded >1.6 Mg/m^3 (Table, 4).

Table 4. Soil physical and chemical properties of the different mapping units.

Mapping unit	Soil depth (cm)	Slope (%)	EC (dS/m)	ESP	Bulk density (g/cm^3)	Drainage	Texture class
L	150	0.8	5.72	10.12	1.40	Poor	Silty clay
O	120	1.1	1.67	6.67	1.24	Well	Clay
B1	70	2.0	4.76	8.56	1.17	Poor	Clay
B2	110	1.9	0.88	2.74	1.45	Good	Silty clay loam
R1	100	1.2	11.05	9.28	1.19	Good	Clay
R2	115	1.4	7.54	11.37	1.43	Well	Clay loam
R3	120	1.5	2.61	5.93	1.46	Well	Clay loam
T	150	2.0	3.36	7.85	1.60	Well	Sand
S	150	1.7	21.56	13.01	1.73	Well	Sand

Assessment of land degradation hazards.

Soil degradation hazard is illustrated in Table 5. Salinity, sodicity, compaction and water logging are the main degradation hazards in the investigated area. Soils affected by very high hazard of salinity represented 16.70%, of the total area. The very high hazard of compaction was present in 35.15% of the total area as a result of human activities, inadequate soil management, and using heavy machinery. Soils affected by a high hazard of salinity, compaction and water logging represented 14.66%, 3.60% and 20.50% of the total area, respectively. Moderate hazard of salinity, sodicity, compaction and water logging represented 36.50%, 33.70%, 34.00% and 79.50% of the total area, respectively. Salinity, sodicity, bulk density and water table hazards were compiled into the digital geomorphologic map of Figures 6 to 9. .

Table 5. Rates of land degradation of the studied area.

Mapping unit	S	A	C	W
L	M	M	M	M
O	L	L	H	M
B1	M	L	VH	H
B2	L	L	M	M
R1	H	L	VH	M
R2	M	M	M	M
R3	L	L	M	M
T	L	L	M	M
S	VH	M	L	M

Note: S = Salinization, A =Alkalinization, W= Water logging, C = Compaction, L = Low, M = Moderate, H = High, VH = Very High.

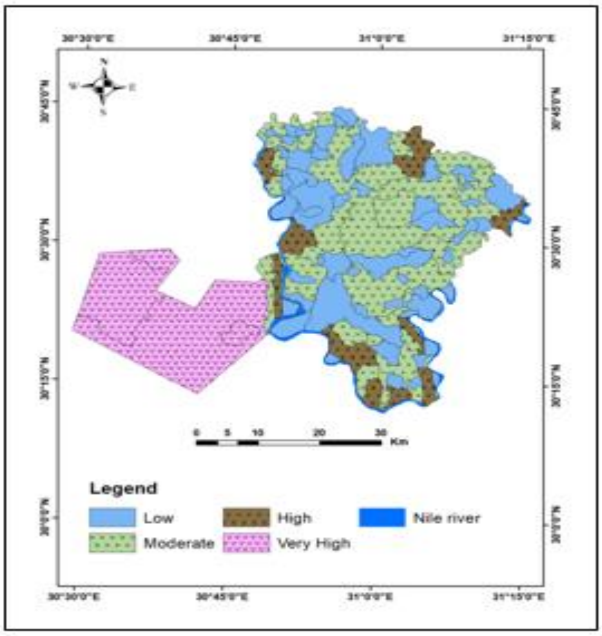

Figure 6. Spatial distribution of EC (dS/m).

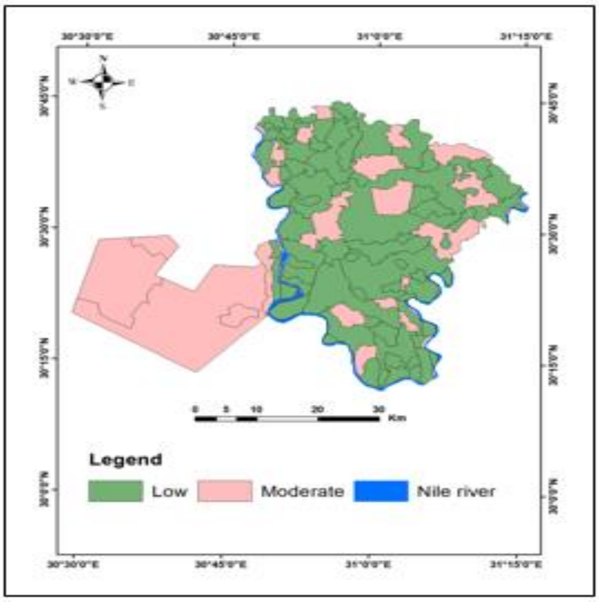

Figure 7. Spatial distribution of ESP.

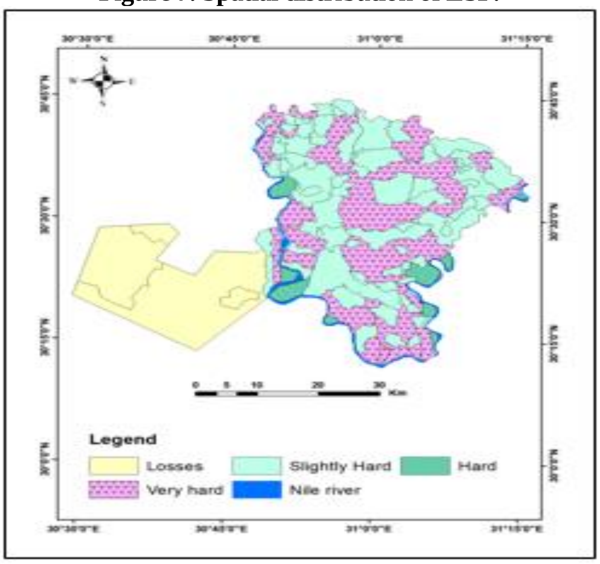

Figure 8. Spatial distribution of bulk density (g/cm^3).

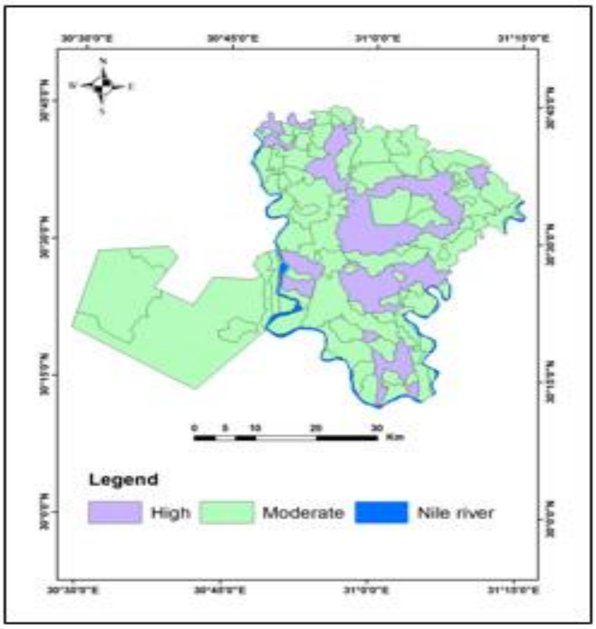

Figure 9. Spatial distribution of soil depth (cm).

Land degradation risk model.

A simple model for assessing land degradation risk (LDR) was based on the equations provided by FAO/UNEP (1978, 1979) and governed by several factors; in definite ways considering physical and chemical aspects (Figure 10). The following steps explain the mechanism of the LDR model:

1- Analysis of DEM data indicated that the slope gradient in the study area ranged between 0.8% and 2.0%, thus the rating of topographic (RT) was 1.0 in both physical and chemical degradation risk.

2-Calculataion of the climatic rating of chemical degradation risk is according to the following (eq. 1):

$RCc = PE/(AP + Q)10$……………………..…. eq.(1)

Where RCc = the climatic rating of chemical degradation risk, PE = the potential evapo-transpiration, AP = the annual precipitation and Q = the amount of irrigation water used in mm.

When using saline ground water, the climatic rating of chemical degradation risk is calculated using the following (eq. 2):

$RCc= (PE/1000)*EC_{gw}$………………………eq. (2)

Where EC_{gw} = the ground water salinity.

3- Calculation of the climatic rating of physical degradation risk according to the following (eq. 3):

$RCp=\sum MP^2/AP$……………………………eq. (3)

Where RCp = the climatic rating of physical degradation risk, MP = the monthly precipitation in mm and AP = the annual precipitation in mm.

4- The soil texture rating for chemical degradation risk (RSc) in the deep profiles is 0.1, 1 and 1.5 for coarse, medium and fine texture, respectively. In the case of shallow profiles the used soil rating is 1, 2 and 3 for coarse, medium and fine texture, respectively.

5-Calculataion of the soil texture rating of physical degradation risk is according to the following (eq. 4):

$RSp= Si/C$…………………………….……………eq. (4)

Where RSp = the soil texture rating for physical degradation risk, Si = the percentage of silt and C = the percentage of clay.

6- The land degradation risk (LDR) was calculated for the different mapping units according to the following (eq. 5):

Land Degradation Risk (LDR) = RC×RS×RT….eq. (5)

7- After preparation, of final data of physical and chemical properties the LDR was calculated the spatial analysis in ArcGIS 10.2 of the most constraining factors.

8- The rating of the land degradation risk is done according to the grading system of FAO/UNEP (1978, 1979) as shown in the following (Table 6).

Table 6. Degradation risk Classes and ratings.

Degradation risk class	Rating	Class name
1	<2	Low
2	2-4	Moderate
3	4-6	High
4	>6	Very high

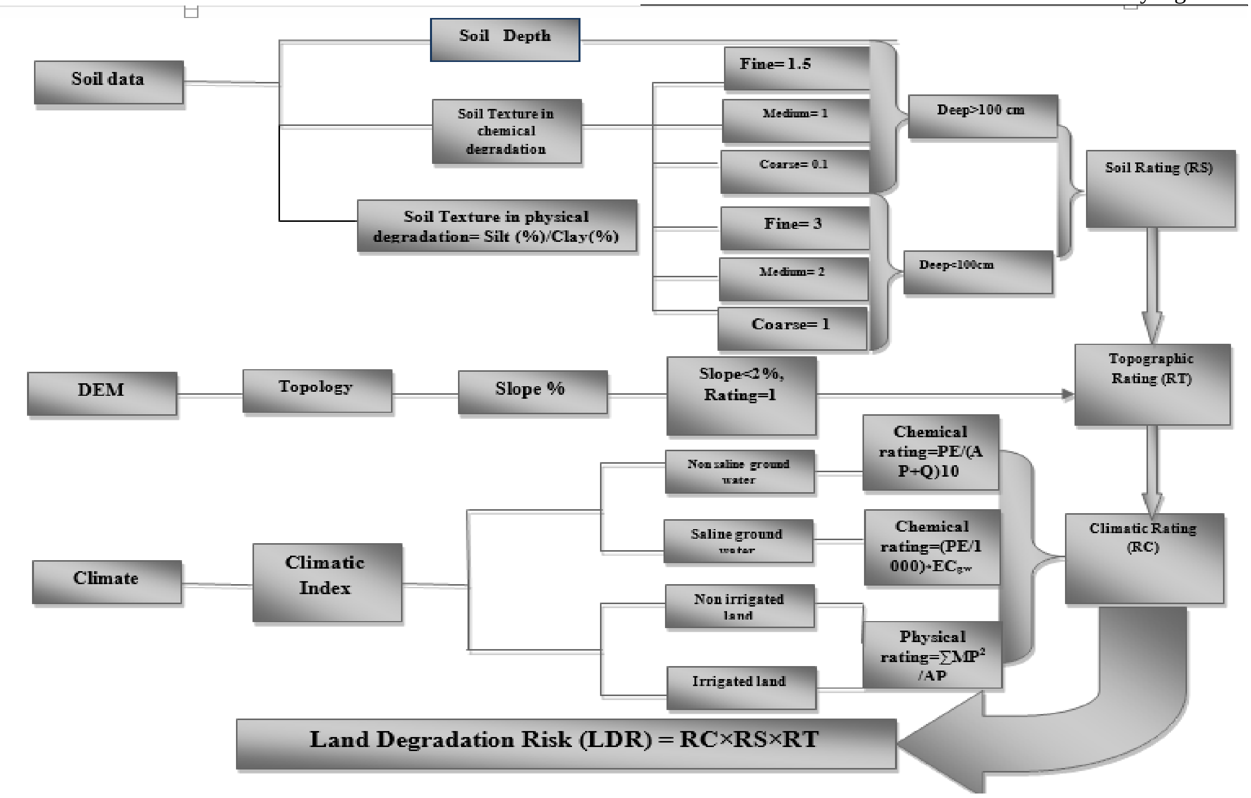

Figure 10. Flowchart of land degradation risk model.

Determination of land degradation risk (LDR).

Table 7 shows the risk of chemical degradation is low in all including soils of O, B1, R3, T and S mapping units. These soils covered an area of 108146 ha representing 49.80% of the study area. An area of 86075 ha representing 39.60 % of an area of study area was of very high risk of chemical degradation in soils of L, B2, R1 and R2 mapping units. The risk of physical degradation ranged between low and moderate classes throughout the whole study area. The areas threatened by low risk values were located in soils of L, O, B1, B2, R1, R2 and R3 mapping units covering an area of 157324 ha (72.45 % of the total area). An area of 36897 ha representing 17.00 % of the study area was characterized by moderate risk of physical degradation in soils of T and S mapping units. Figures 11 and 12 and Tables 8 and 9 show the chemical and physical degradation risk in the investigated area.

Figure 13 and Table 10 present the degradation risk in the study area. The obtained data reveal that soils of L, B2, R1 and R2 units in the flood plain which represent 39.6% of the study area have a very high risk of chemical degradation and low risk of physical degradation. The soils of O, B1and R3 units which represent 32.8% of the study area are subjected to a low risk of both physical and chemical degradation. The soil of the T unit in the flood plain and soil of the S unit in the aeolian plain have a low risk of chemical degradation and moderate risk of physical degradation, which represent 17.0% of the study area.

Table 7. The computed chemical and physical degradation risks in the studied area.

Mapping unit	Chemical degradation risk = RS×RT×RC						Physical degradation = RS×RT×RC					
	RS	RT	RC	Risk	Class		RS	RT	RC	Risk	Class	
L	1.0	1	6.60	6.60	4	VH	1.31	1	1.03	1.35	1	L
O	1.5	1	0.04	0.06	1	L	0.28	1	1.03	0.29	1	L
B1	1.5	1	0.04	0.06	1	L	0.46	1	1.03	0.47	1	L
B2	1.0	1	15.53	15.53	4	VH	0.63	1	1.03	0.65	1	L
R1	1.5	1	8.27	12.41	4	VH	0.43	1	1.03	0.44	1	L
R2	1.0	1	11.75	11.75	4	VH	1.31	1	1.03	1.35	1	L
R3	1.0	1	0.04	0.04	1	L	1.06	1	1.03	1.10	1	L
T	1.0	1	0.04	0.04	1	L	2.84	1	1.03	3.01	2	M
S	0.1	1	0.04	0.004	1	L	3.13	1	1.03	3.22	2	M

Note: RS: soil rating, RT: topographic rating and RC: climatic rating.
L=Low, M=Moderate and VH=Very high.

Table 8. Distribution of chemical degradation risk in the study area.

Chemical degradation risk rating	Grade	Class	Mapping unit	Area (ha)	Area %
<2	1	Low	O, B1, R3, T and S	108146	49.80
2-4	2	Moderate	-----------	---------	----------
4-6	3	High	-----------	----------	----------
>6	4	Very high	L, B2, R1 and R2	86075	39.64

Table 9. Distribution of physical degradation risk in the study area.

Physical degradation risk rating	Grade	Class	Mapping unit	Area (ha)	Area %
<2	I	Low	L, O, B1, B2, R1, R2 and R3	157324	72.45
2-4	II	Moderate	T and S	36897	17.00
4-6	III	High	---------------	---------	------------
>6	IV	Very high	---------------	---------	-------------

Table 10.Distribution of total land degradation risk in the study area.

Land degradation risk class	Grade	Mapping unit	Area (ha)	Area %
Very high-Low	VHL	L, B2, R1 and R2	86075	39.60
Low-Low	LL	O, B1and R3	71249	32.80
Low- Moderate	LM	T and S	36297	17.00

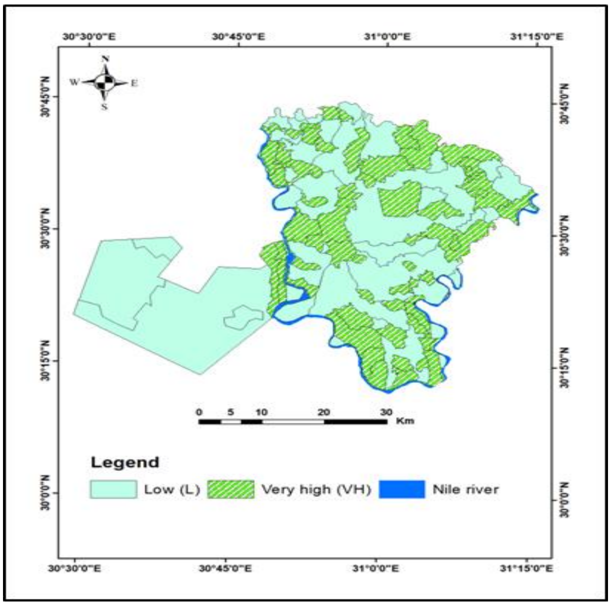

Figure 11. Chemical degradation risk in El-Minufiya Governorate.

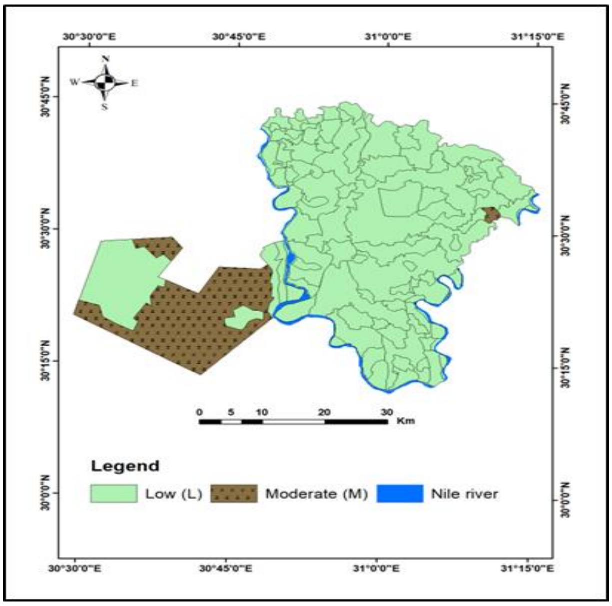

Figure 12. Physical degradation risk in El-Minufiya Governorate.

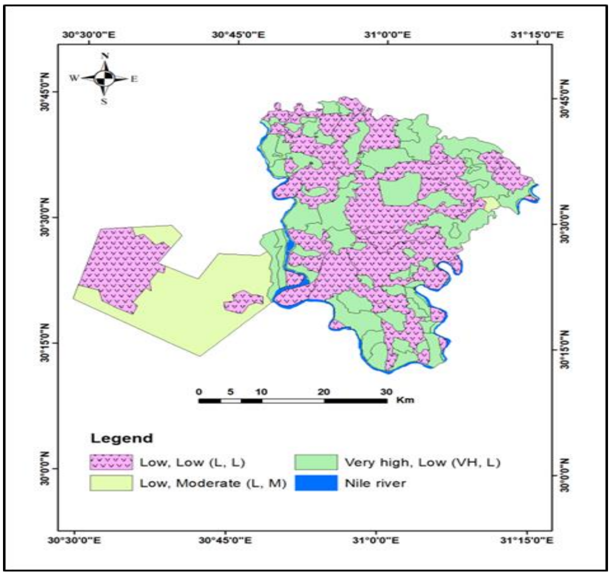

Figure 13.Land degradation risk in El-Minufiya Governorate.

CONCLUSION

The soils in El-Minufiya Governorate was low to very high hazards of salinity and compaction, low and moderate hazards of alkalinity, and moderate to high hazards of waterlogging. Reasons are over irrigation, improper use of heavy machinery and absence of conservation measurements. The risk of degradation ranged between low and very high chemical risk but low to moderate physical risk. Satellite data monitored the changes of land use/land cover in the studied area. There were three classes identified in the studied area in 1987 and 2018, the agricultural area, urban sprawl and the bare land areas. Area of agriculture land increasing by 23412.78 ha. Urban area increased increasing by 14903.82 ha. The area of bare land decreasing by 38316.60 ha. The changing patterns of human life, human activities and increasing population growth in the study area have accelerated the environmental degradation. Salinization, compaction and urban sprawl are the dominant land degradation processes in the studied area.

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تقييم خطر تدهور الأراضى فى محافظة المنوفية، مصر

هبة شوقى عبدالله راشد

قسم الأراضى والمياه- كلية الزراعة- مشتهر- جامعة بنها- مصر

محافظة المنوفية تمثل نموذجا للزراعة التقليدية فى دلتا النيل بمصر، وتشمل أراضى زراعية قديمة وأراضى مستصلحة حديثا وتحتل المحافظة مساحة قدرها ٢١٧١٦٠,٠ هكتار. ويعد التكامل بين تقنية الإستشعار من بعد وتقنية نظم المعلومات الجغرافية مستخدم فى التحديد الكمى لخطر التدهور بمنطقة الدراسة. تم حفر ١٥ قطاع أرضى وتم وصفهم وأخذ عينات التربة. ويوجد بمنطقة الدراسة شكليين أساسيين للأرض وهما: السهل الفيضى والسهل الريحى. والوحدات الأرضية هى: كتف النهر، الرفوف الفيضية، الأحواض الفيضية،الاحواض التجميعية، الشرفات النهرية الحديثة (العالية والمتوسطة والمنخفضة)، ظهور السلاحف والفرشات الرملية. الأراضى المتأثرة بتدهور عالى جدا فى الملوحة وتضاغط التربة تمثل ١٦,٧%و ٣٥,١٥% على التوالى من منطقة الدراسة الكلية بسبب النشاط الانسانى والادارة الغير جيدة للتربة واستخدام المعدات الزراعية الثقيلة. والأراضى المتاثرة بتدهور عالى فى الملوحة، التضاغط، منسوب الماء الأرضى تمثل ١٤,٦٦%، ٣,٦%، ٢٠,٥٠% من المساحة الكلية لمنطقة الدراسة على التوالى. أما الأراض المتأثرة بخطر متوسط فى الملوحة والصودية والتضاغط ومنسوب الماء الأرضى تمثل ٣٦,٥٠%، ٣٣,٧٠%، ٣٤,٠٠% و ٧٩,٥٠% من امساحة الكليةعلى التوالى. النموذج الرياضى المبسط المستخدم فى تقييم خطر التدهور مصمم على أساس معادلة رياضية. نسبة ٣٩,٦% من منطقة الدراسة تكون عالية جدا فى التدهور الكيميائى ومنخفضة فى التدهور الفيزيائى. ونسبة ١٧,٠% تمثل تدهور كيميائى منخفض وتدهور فيزيائى متوسط. ونسبة ٣٢,٨% من منطقة الدراسة تمثل تدهور منخفض لكلا النوعين الكيميائى والفيزيائى. الملوحة والصودية والتضاغط وأرتفاع منسوب الماء الأرضى تمثل أخطار التدهور الأساسية بمنطقة الدراسة وتكون شدتها من منخفضة الى عالية جدا. التغيرات الحادثة فى استخدام الأراضى والغطاء الأرضى فى الفترة مابين ١٩٨٧ و ٢٠١٩ تعطى مؤشرا على حدوث الزحف العمرانى بمنطقة الدراسة. معظم أراضى منطقة الدراسة أظهرت أختلاف فى أقسام أستخدام الأرض والغطاء الأرضى وذلك راجع الى النشاطات الزراعية والزحف العمرانى.