Degradation Hazard Assessment of Some Soils North Nile Delta, Egypt

M. A. Wahab[1], M. A. Rasheed[2] and R. A. Youssef[3]
Soils and Water Use Dept. National Research Centre, El Buhouth St., 12311, Giza, Egypt

[1]Prof Dr. Mohamed Ahmed Wahab, Email: mohamedwahab@ yahoo.com
[2]Prof. Dr. Mohamed Abas Rasheed, Email: marasheed_snrc@yahoo.com
[3]Prof. Dr. Refaat Abd El Kawey Youssef, Head of soils and water use Dept., Email: refatay1@yahoo.com

Abstract: This study aimed to identify and quantitatively evaluate land degradation processes in the northern Nile Delta region. Aerial photographs were used to follow the geo-indicators of different degradation processes. GIS is used to build up a database model including required parameters for obtaining inputs to the model implemented by FAO/UNEP for global assessment of land degradation. The obtained results reveal that the high risk of physical (i.e. soil compaction and water logging) and chemical vulnerability (i.e. salinization and alkalinization) cover an area of 18487 hectare and 11008 hectare, respectively. The human induced land degradation hazards due to soil compaction is slight to high, however moderate to high for water logging. The degree of salinization and alkalinization is slight to high. [Nature and Science 2010;6(6):156-161]. (ISSN: 1545-0740).

Keywords: soils degradation, remote sensing, GIS, North Nile Delta

1. Introduction

The total cultivated area of the Nile Delta is 4, 354, 382 feddans (1741753 hectare) representing 55.5% of the cultivated land of Egypt. The Nile Delta, as well as arid land, is threatened by water logging, soil compaction, salinization and alkalinization **(El Gabaly, 1972**, **Gad & Abel Samei, 1998, and El Kassas, 1999).**

Land degradation was identified by different authors **(i.e. FAO/UNEP 1978, Warren, & Agnew 1988, Lal, & Stewart 1990 and Wim, & El-Hadji 2002)** as the processes which lower the current and / or the potential capability of the soils. **FAO/UNEP 1984, Dregene et al. 1995, and Condom et al., 1999** referred that soil degradation includes six types of processes (i.e. water erosion, wind erosion, excess of salts, chemical degradation, physical degradation and biological degradation.

The study area is located in the north of the Nile Delta (Figure, 1). This area belongs mainly to Kafr El-Sheikh governorate stretching between longitudes 31o 45′ and 31o 55′ east and latitudes 31o 12′ and 31o 30′ North, with a total area of 124044 hectare. According to **Egyptian Meteorological Authority (1996)** the mean annual temperature of the representative metrological station (i.e. Sakha) reaches its maximum (26.4 c^{o}) in August and minimum (11.0 c^{o}) in January, February and March. The amount of average annual rainfall is very low and mostly falls in winter, as it reaches 6.5 mm/year. and drainage network exist in the area since 1820. This irrigation system, caused natural drainage to be The evaporation values show that it ranges between 34.3 and 81.7 mm. The relative humidity ranges between 54.2, in May, and 68.6 %, in December and January.

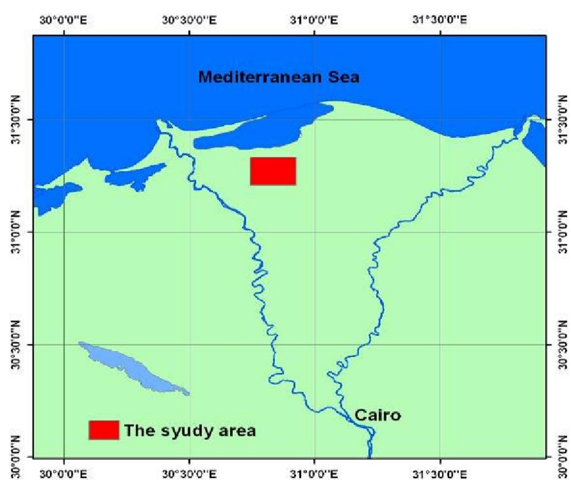

Figure 1. Location of the study area

Concerning the geology of the study area, **Shata, and El Fayoumy, (1969)** pointed out that the northern regional structure of the Nile Delta is a portion of a major downward and zone charactering the unstable shelf region of north Egypt. The geomorphic units of the area south El Borolus Lake are alluvial plain and fluvio lacustrine **(Abou El Enain, 1997)**. Irrigation insufficient to drain the soils, and an artificial drainage system was required.

The purpose of this study is to identify and quantitatively evaluate land degradation processes in the northern Nile Delta region.

2. Material and Methods

Panchromatic aerial photographs scale (1: 40.000) which were taken during the year (1991) consisting of 48 aerial photographs has been used to produce the physiographic map of the study area, using "the physiographic analysis" detailed by **Zinck, and Valenzuala (1990)**. The field work has been planned in two transects crossing different mapping units. A number of 15 soil profiles, representing different mapping units were studied. Forty four soils samples were collected, analyzed and classified, to the level of sub-great groups, according to **(USDA, 2003 & USDA, 2004)**. ArcGIS, version 9.2 has been used as the main GIS software for the purpose of producing geo-referenced maps to evaluated land degradation processes.

Measurements units and rating of degradation classes specific to each group of processes have been chosen according to **FAO/UNEP (1978)**. Natural vulnerability was calculated on basis of soil, topography and climatic factors adopted in the universal soil loss equation. Degradation hazard was also estimated using the current values of soil depth, bulk density, EC and ESP.

3. Results and discussions:

3.1- Physiography of the studied area

Compatible with **Abou El Enain, (1997)** the Physiographic analysis of panchromatic aerial photographs, made it possible to define two main landscapes types dominating the area (i.e. Flood plain and Fluvial-lacustrine plain). Moreover, it was possible to recognize the landforms of river terraces, over flow mantle, levees and basins within the flood plain. Also, a number of 6 landforms were identified in the Fluvial-lacustrine plain (i.e. Terraces of various elevations, over flow mantle, man-made terraces, overflow and decantation basins, levees and turtle backs). Figure (2) show the physiographic units of studied area.

3.2- Soils of the studied area

The morphological study and analytical data of 15 representative soil profiles made it possible to classify the soils in two orders (Aridisols and Entisols). Four great groups were identifies coinciding with the mapped land forms (**Abou El Enain, 1997)**. Table (1) shows some physico-chemical properties and soil taxonomy of mapping units.

Table 1. The main characteristics of different mapping units

landscape	landform	Symbol	Soil depth (cm)	Bulk density g/cm^3	EC dS/m	ESP %	Taxonomic unit
Alluvial plain	Decantation basin	APd	100	1.28	6.9	15.3	*Typic Torrifluvents*
	High terraces	Apt1	60	1.31	8.3	14.6	*Typic Torrifluvents*
	River levees	APl	90	1.28	4.7	15.2	*Vertic Torrifluvents*
	Low terraces	APt3	100	1.31	7.2	18.3	*Vertic Torrifluvents*
	Moderately high terraces	APt2	100	1.22	4.6	12.3	*Typic Haplargids*
	Overflow basin	APo	70	1.29	6.3	9.7	*Typic Haplargids*
	Overflow mantle	APm	75	1.21	13.1	14.6	*Vertic Torrifluvents*
Lacustrine plain	Decantation basin	LPd	60	1.32	16.5	13.2	*Typic Haplargids*
	High Terraces	LPt1	110	1.26	3.7	14.5	*Vertic Torrifluvents*
	River levees	LPl	110	1.33	5.1	12.9	*Vertic Torrifluvents*
	Low Terraces	LPt3	100	1.34	4.9	11.4	*Typic Torrifluvents*
	Moderately high terraces	LPt2	90	1.42	5.8	33.5	*Vertic Torrifluvents*
	Overflow basins	LPo	70	1.36	12.9	15.2	*Vertic Torrifluvents*
	Overflow mantle	LPm	90	1.22	6.7	11.5	*Typic Torrifluvents*
	Man-made terraces	LPmt	70	1.33	10.6	16.8	*Typic Torrifluvents*

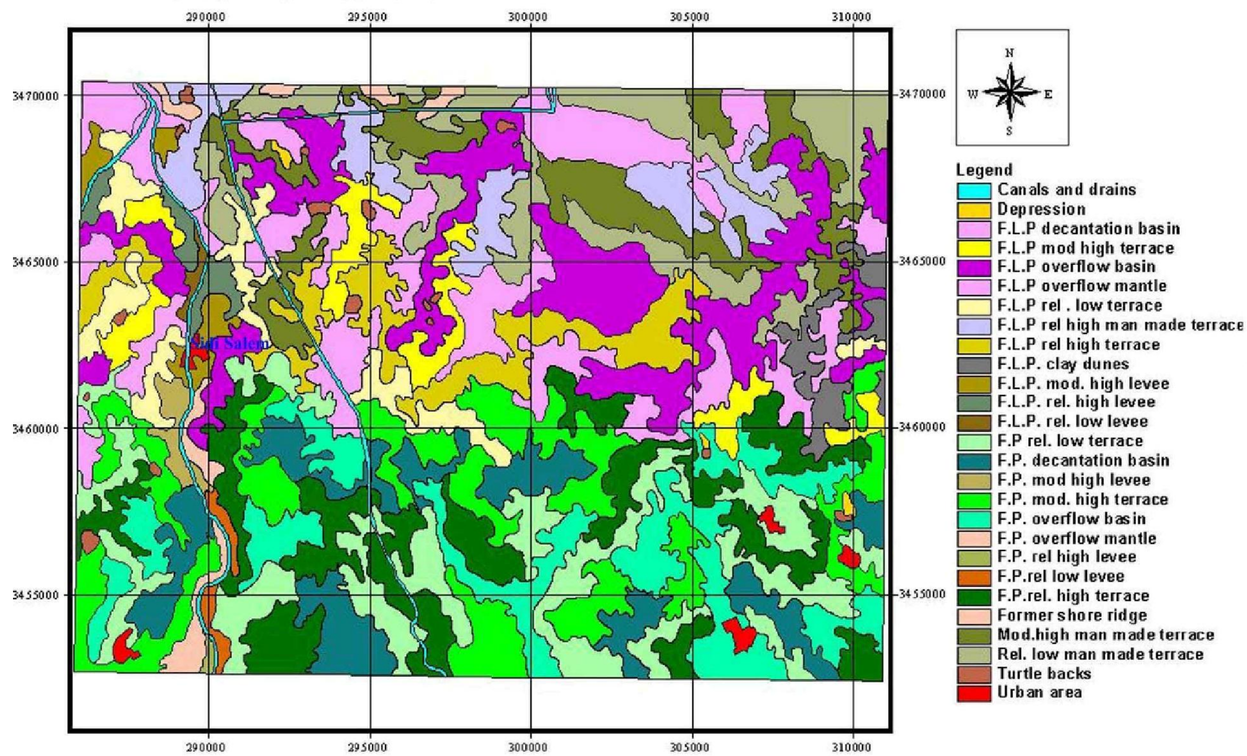

Figure 2. Physiographic units of the studied area

3.3- Natural vulnerability

Figure (3) and table (2) present the natural vulnerability in the north Nile Delta area for the different mapping units. The obtained data reveals that the soils of river terraces in the flood plain (Apt) have a slight to high risk of physical degradation and slight to moderate chemical degradation. The soils of over-flow mantle (APm) and decantation basin (LPD) are subjected to a moderate risk of physical vulnerability, while slight risk of chemical vulnerability. The soils of over-flow basin (APo), decantation, (APd), moderate and high river terraces of the fluvial-lacustrine plain (LPt2, and LPt3) and levees (LPl) have a moderate risk of both physical and chemical degradation. The soils of low river terraces in the fluvial-lacustrine plain (LPt1) have a high physical degradation and slight chemical degradation. In the fluvial-lacustrine, the soils of man made terraces (LPmt), overflow basin (LPo) and sodium percentage, bulk density and the depth of water table range between (3.7-16.5) d S /m, (9.7-33.5) %, (1.21-1.42) g/Cm³ and (60-110) Cm., respectively (table 1).

The soil degradation is mostly resulted from improper land management. The main types of human induced land degradation in the investigated areas are salinization, alkalinization, soil compaction and water logging. Human induced salinization and overflow mantle (LPm) are characterized by slight physical degradation risk and moderate chemical risk. Table (2) shows the input and out put values of calculating the natural vulnerability in the studied area. Table (3) shows that a significant area (45.1% of study area) is exhibited by a moderate physical degradation class and slight chemical degradation. The area that characterized by a slight class of both physical and chemical degradation is restricted to be only 8.5% of study area.

3.4- Degree of land degradation

The degree of four human induced land degradation processes (i.e. water logging, soil compaction, slainization and alkalinization) was estimated in relation to the depth of water table, bulk density, electric conductivity and exchangeable sodium percentage. In the north Nile Delta, the present values of electric conductivity, exchangeable alkalinization can be caused by poor management of irrigation schemes, usage of saline irrigation water and inefficient drainage. This type of salt accumulation mainly occurs under arid and semi-arid condition. Salinization and or alkalinization may be also caused by intrusion of sea water or fossil saline ground water bodies to the ground water reserves of good quality. Soil compaction mainly occurs in the soils with low structure stability, under the improper human activities. In the studied areas soil compaction result from improperly timed use of heavy machinery, misuse of irrigation, absence of conservation measurements, shortening of the fallow period and the excessive use of chemical fertilizers. Water logging is caused by the misuse of irrigation techniques leading to flooding, especially in heavy clay soils. Also, inefficient drainages, and destruction of subsurface drainage networks by uncontrolled plough (in some parts) are causes of water logging in the studied areas.

Table 2. Factors of input elements, values and classes of natural vulnerability

Profile No.	Symbol	Physical Degradation				Chemical Degradation			
		Climate	Soil	Value	Class	Climate	Soil	Value	Class
1	APd	0.1	0.93	0.1	M	0.12	1	0.12	M
2	Apt1	0.1	0.76	0.2	H	0.12	0.5	0.0.6	S
3	APl	0.1	0.41	0.07	S	0.12	1	0.12	M
4	Apt3	0.1	0.71	0.04	S	0.12	1	0.12	M
5	Apt2	0.1	0.98	0.1	S	0.12	1	0.12	M
6	APo	0.1	1.08	0.1	M	0.12	1	0.12	M
7	APm	0.1	1.40	0.1	M	0.12	0.5	0.06	S
8	LPd	0.1	1.65	0.14	M	0.12	0.5	0.06	S
9	LPt1	0.1	1.15	0.2	H	0.12	0.5	0.06	S
10	LPl	0.1	1.13	0.11	M	0.12	1	0.12	M
11	LPt3	0.1	1.08	0.11	M	0.12	1	0.12	M
12	LPt2	0.1	0.95	0.11	M	0.12	1	0.12	M
13	LPo	0.1	0.86	0.09	S	0.12	1	0.12	M
14	LPm	0.1	0.81	0.08	S	0.12	1	0.12	M
15	LPmt	0.1	0.65	0.08	S	0.12	1	0.12	M

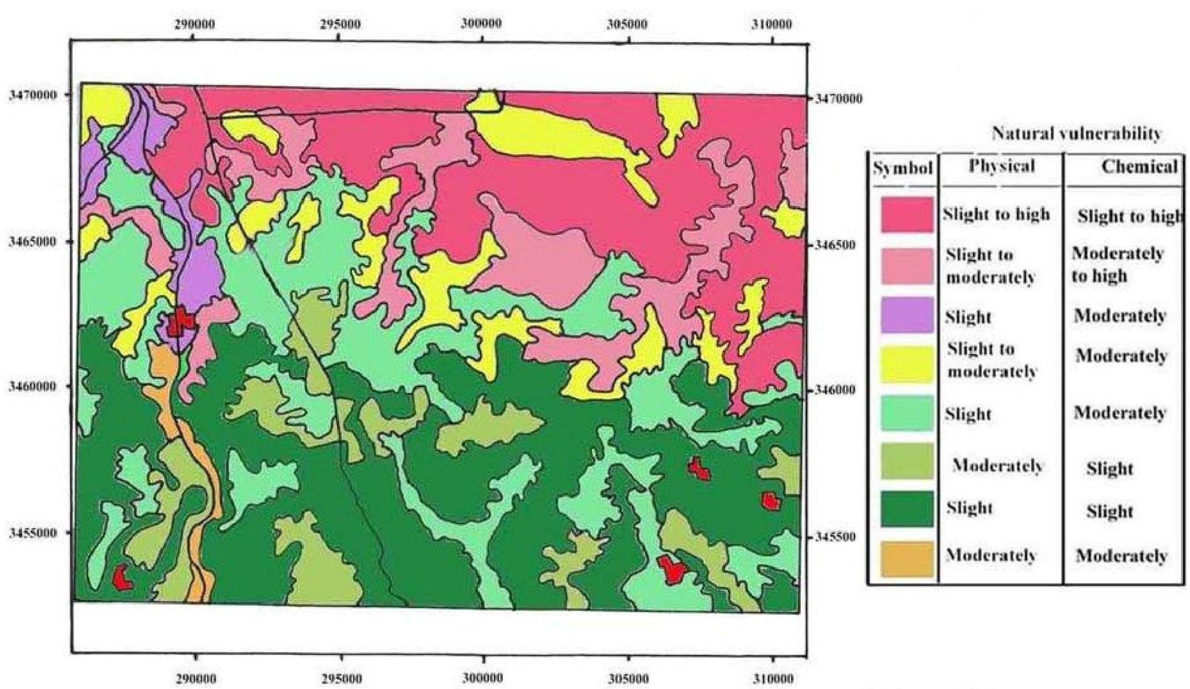

Figure 3. Natural vulnerability classes

Table 3. Classes of degradation hazard in the study area

landscape	landform	Symbol	Area (hectare)	Type of land degradation			
				W	C	S	A
Alluvial plain	Decantation basin	APd	21951	1	2	2	1
	High terraces	Apt1	9797	3	2	3	1
	River levees	APl	801	2	2	2	1
	Low terraces	APt3	9051	1	2	2	2
	Moderately high terraces	APt2	6528	1	1	2	1
	Overflow basin	APo	11008	3	2	2	1
	Overflow mantle	APm	2504	2	1	3	2
Lacustrine plain	Decantation basin	LPd	10927	3	2	4	2
	High Terraces	LPt1	2536	1	2	1	1
	River levees	LPl	1488	1	2	2	1
	Low Terraces	LPt3	7559	1	2	2	1
	Moderately high terraces	LPt2	481	2	3	2	3
	Overflow basins	LPo	6018	3	3	3	1
	Overflow mantle	LPm	1875	2	2	2	1
	Man-made terraces	LPmt	11967	3	1	3	2

W: Water logging, C: Compaction, S: Salinization, A: Alkalinization. 1= Slight, 2= Moderate, 3= Hig

4. Conclusion

It can be concluded that a significant area in the northern Nile Delta is subjected a high risk of physical and chemical degradation. Moreover, processes of water logging, soil compaction, soil salinity and alkalinity are slight to high in different land units. GIS is very helpful tool to store, manipulate and quantitatively evaluate soil degradation. Remote sensing is a satisfactory source of ground truth information needed in parametric evaluation.

Correspondence to:
Prof. Dr. Refaat Abd El Kawey Youssef, Head of soils and water use Dept., NRC, El Buhouth St. 12311, Giza, Egypt
Telephone: (+202) 33371362; (+202) 33371433
Email: refatay1@yahoo.com

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