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DELINEATING RICE BELT CULTIVATION IN THE NILE PRO-DELTA OF VERTISOLS USING REMOTE SENSING DATA OF EGYPTSAT-1

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ABSTRACT: *Delineation of aquatic rice belt cultivation is one of the formal practices to find more adaptation in the northern parts of Nile Delta. The case is to save amounts of water resources and to integrate hydraulic pressure for protecting the Pro-Delta from the sea water intrusion. Egypt Sat-1data were used for delineating the Pro-Delta to be proposed as rice belt region. This Pro-Delta have soils of heavy textured class with high water holding capacity as indicated by the soil water saturate percent "SP". The weight average of SP for each soil profile ranged from 77.5 to 118.2 cm^3/100gm. with mean of 96.8 cm^3. /100gm. for rice belt area. The soils that are surrounding the rice belt area have coarser textured classes including weight average of SP values for each soil profile ranged from 19.1 to 59.1 cm^3/100 gm. resulting in 37.0 cm^3./100gm. as a mean value. Water loss is expected when rice cultivation is managed outside of the rice belt being this belt have capacity of holding water as ٢,٦ times (96.8/37= 2.6) more than the other soils outside that belt. The soils in the of rice belt were categorized as Vertisols, of unique behavior to the root zone, especially in the arid climate as in Egypt. The best case for managing Vertisols is to be wet avoiding the problems of soil shrinkage, Stalinization and sodocity processes realizing an extra adaptation between vertisols behavior and aquatic rice practices comparing to the other cropping patterns. The delineated rice belt area is covering about 1197201.3 hectares as trees crops "226822.7 hectares" and herbaceous crops "748874.8 hectares. The non vegetated areas include urbanized one "133811.3 hectares", linear coverage of roads and canals "52500.0 hectares" and fish ponds "35192.4hectars". The specified area for rice belt cultivation is that residual one as herbaceous crops "748874.8 hectare" which can be managed for rice within the total rice belt area. The path of this rice belt is highly recommended to separate between two developed types of irrigation as surface irrigation in the proposed rice belt area and the modern irrigation by drip or sprinkling methods outside this rice belt*

Key Words: *Egyptsat-1, Rice belt cultivation, Vertisols, Nile Prodelta.*

INTRODUCTION

River Nile Delta should be perpetually managed for a formal agriculture land use as having a unique natural adaptation of Land and River Nile of a very high economical value that can not be designed by man-mad in elsewhere even with high capital intensity. The study aims to trace one of the formal solutions for realizing an extra adaptation over this Delta by delineating rice belt cultivation. The case will maximize yield production as well as protecting the pro-delta from the hazards of sea water intrusion. Scientists and technocratic decision makers who have the related interest may realize the importance of this task since they strongly believe of some facts that are belonging to this proposed rice belt as follows:

a) It is highly recommended to manage soils for aquatic rice cultivation to be fit in the northern part of Nile Delta, situating around the end points of the River Nile flow. Flooding water over the rice fields help to push forwards the sea water intrusion by accumulating hydraulic pressure that face the backwards erosion, over this Pro-Delta.

b) The high water requirement for the aquatic rice cultivation is considered a loss of water if this cultivation is managed, conflicting with the concept of the proposed rice belt. According to APRP (1999) rice requires a water application of about 1,900 mm, which is much higher than other summer crops as about 1,380 mm for cotton and about 1,000 mm. for maize. The informal water management lead to the exaggeration of water loss as affected by the soil attribute variation, which are mainly relating to the drainage condition and the water holding capacity. According to El-Araby et al (1987), Vertisols or the heavy clay soils are dominating the northern part of Nile Delta as adjacent to the northern Delta lakes of Egypt. When other soils (not Vertisols) are to be managed for growing rice, the irrigation water is most probably rapidly drained and an extra water is required or to gain less rice yield production. This water management can not be accepted as Egypt is facing a difficult task of finding solutions for the water resource deficiency, which is going to be a big problem. Acting with this problem, Afify (2009) pointed out that tracing extra water resources must become a profound part of our interests to formulate a firm policy of building up assets and integrating experience for this purpose. Although desalination of sea water is currently supporting both drinking and industrial purposes, in future will be much needed for the managed agriculture. On other hand Mohammed1999 stated that water use efficiency and water management is of critical importance to be considered by the government.

c) The informal land use for rice cultivation exaggerates the environmental problems, in a vast region of Northern Egypt. This cultivation is currently and traditionally cause yearly air contamination depending on the scheduled times after rice harvesting for burning rice straws. The environment is negatively affected as the air is loaded by exhausts, which move over the arable and urbanized areas. It is complementary reasons for an intelligent study to realize and to confirm the idea of tracing the border of the proposed rice belt for retreating and moving the rice cultivation area northwards over the Nile Delta. Accordingly the delineation of rice belt along a specific path is geographically assigned to be exactly well known based on systematic and uniform cartographic and mapping specifications.

MATERIALS AND METHODS

Selected study area

The site of the study area was located to represent the Nile Delta including the provinces that are managing rice cultivation (figure 1). The study area is located between 30° and 32° East and between 30° and 31° 30' North.

Visual interpretation of Egypt sat-1data

The spectral signatures of the physiographic features of the study area were based on Egyptsat-1 data 2009. These data have spatial resolution of 7.8 meters and spectral resolution of 0.51 - 0.59 µm "Green band", 0.61 - 0.68 µm "Red Band" and 0.80 - 0.89 µm "Near Infrared band". The combined bands were rectified to fit the international system (UTM) Universal Transfer Mercator. The spectral signatures were interpreted for the assessment of physiographic unit's delineation, applying the physiographic approach as proposed by Goosen (1967) and based on the author's local reference level. The delineated infra structures and villages that are surrounding the delineated pro delta were named to be a practical guide for the rice belt with the aid of the geographic maps of scale 1: 50000

Ground truth:

The preliminary physiographic border refined during the ground truth to emphasis the boundaries between the pro delta and the other surrounding units. Fifty seven (57) pedons were chosen to represent the different physiographic units in the study area. Soil profiles were dug to 100 cm to confirm the hypothesis that Vertisls is dominating Pro-Delta. Five representative soil profiles were dug to the depth of 150 cm. for detailed soil description. The soils were described according to the nomenclature of Soil Survey Manual (USDA 2003).

Laboratory analyses:

-Particle size distribution was carried out using the pipette method (Piper, 1950).

-Soil saturation percent (SP) as water quantity in the mode of soil paste (Black *et al.*, 1965).

-Calcium carbonate was measured, using calcimeter (Black *et al.*, 1965).

-Gypsum content was determined by precipitation with acetone (USDA, 1954).

-Salinity was expressed as electrical conductivity (EC) in the soil paste extract (Carter and Gregrich, 2007).

Soil classification

The soils were categorized according to the Keys to Soil Taxonomy (USDA, 2010), which based on the climatic data that represent the study area as issued by the Meteorological Authority of Egypt .

Automated classification of the land cover components

Land cover classes were assessed as areas by running the module of unsupervised classification using the Erdas Imagine cartograpgic software. The process led to identify the land cover classes in the proposed rice belt region. Land cover classification was defined based on the Land Cover Classification System (FAO, 2004).

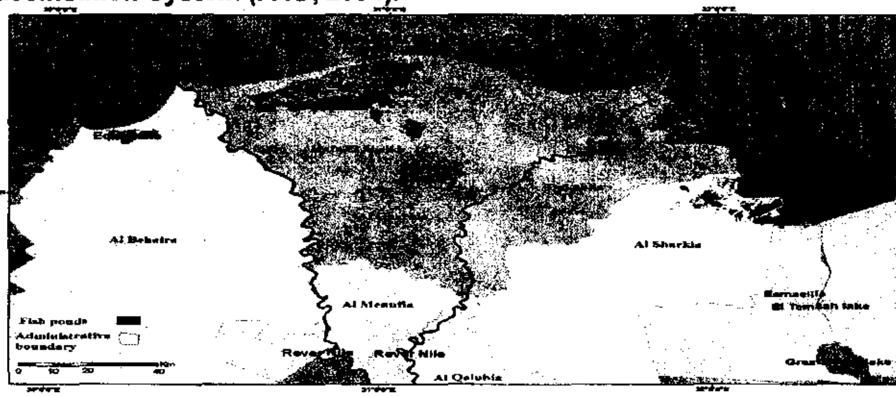

Figure (1) Location map of the study area

RESULTS AND DISCUSSION

Delineating the physiographic features of the proposed rice belt region:

The proposed region for rice belt cultivation was delineated applying the physiographic approach that proposed by Goosen (1967) by tracking ground qualities that associated with River Nile floodplain of level landscape. This area is in dominance represent the front part of the Delta to be defined as River Nile Pro- Delta. The area reflects the delta mechanism and nature of deposition processes, which was previously occurred by the River Nile in this section as the end stages of precipitation. The sediments in this pro-delta are characterized by fine grain size distribution as compared to the other physiographic units that are surrounding the pro-delta including variety of physiographic units, which had been excluded from the region of rice belt cultivation. These excluded physiographic units are the southern part of Nile Delta, which marks the entrance of Nile Delta (Delta apex). It comprises many overlaps of different alluvial deposits due to their proximity to the ramifications of the River Nile, whether are currently existing or that were previously ceased. Rather excluded physiographic units are the lacustrine and marine sediments and aeolian plains. The rice belt area includes some scattered sub- deltaic sediments, which are mostly used for residential construction purposes

Identification of physical properties of the proposed rice belt cultivation

The territory of front deltaic plain ((pro- delta is characterized by of heavy soil texture (clayey), which in turn express the existence of certain hydraulic attributes as permeability , hydraulic conductivity and water holding capacity. The values of soil saturation percent (SP) were assessed in this study to differentiate between the soil ability of water retention concerning holding irrigation water in both rice belt and outside it. SP is considered in this study being is the nearest mode to the field capacity, which reflects the amount of water that held by the soil when water saturation reaches the so-called soil past as the amount of soil moisture after the irrigation practices. It was found that, soils within the proposed rice belt have large ability for reserving more irrigation water, compared to those soils in outside that rice belt. The statistical process of SP values at the level of soil layers was performed for the soils in both areas considering the soil layer thickness to calculate the weight average for each soil profile and then the overall average for all soil profiles were calculated. The overall average of Saturation Percent (SP) of the soil inside rice belt is 96.8 cm^3 per 100 g soil as averaging ranges from 77.4 cm^3 per 100 g soil to the 118.2 centimeter per 100 g soil for individual soil profiles. These proportional values are shown in Table 1. The SP values were calculated by the following equation that was reported by (Reeves et al., 1948):

Weight average of SP for each soil profile:

$$SP = (SPa \times Da + SPb \times Db + \dots SPn \times Dn) / 100$$

Where:

SP = Saturation percent

D = Layer depth cm.

a, b, n the specified soil layers

Mean of SP for an area

$$SP = (SP1 + SP2 + SP3 + \dots\dots\dots\dots\dots\dots SPn) / n$$

Where:

1, 2, 3: The specified soil profile numbers

n: The total number of soil profiles

In the counterparts outside the proposed rice belt area, physical attributes were much different. Soils in this area include grain size distribution of relatively coarser than those formed in the pro-delta. The soil texture classes vary as sandy clay loam, sandy loam, loamy sand and sand resulting in a relatively less ability for holding the irrigation water (Table 2). This mode is causing in turn more drained irrigation water. The overall average of SP value in is 37 cm^3 per 100 grams of soil ranging from 19.1 to 59.1 cm^3 per 100 g soil for individual soil profiles.

Comparing the soils in rice belt (96.8 cm^3 per 100 grams of soil) with those outside rice belt (37 cm^3 per 100 grams of soil), it was found that the soils in the proposed rice belt area can hold more quantities of irrigation water equivalent more than two and half times (96.8 / 37 = 2.6). This case proved that delineated rice belt cultivation is a well selected region for growing rice and will be a positive step, which leads inevitably to spare large quantities of water resources. With more later on detailed study the considering climate factors, comparisons of the irrigation water requirements for different crops and the real national requirement of rice yield production, values that have closeness to spared water resources can be realized

Table (1): Grain size distribution and SP values of the soils inside the proposed rice belt

Pedon No.	Depth cm		Grain size distribution			Soil texture	Saturation Percent (SP)	Weight average of SP
			Sand %	Silt %	Clay %			
	0-10		33.1	22.3	44.6	Clay	86	
1	10- 50		16.8	28.9	54.3	Clay	98	87.3
	50-100		29.2	30.3	40.5	Clay	79	
	0-15		9.3	33.4	57.3	Clay	102	
2	15- 45		26.7	28.7	44.6	Clay	98	97.8
	45- 65		27.7	24.1	49.2	Clay	82	
	65- 100		18.3	27.5	54.2	Clay	105	
	0-25		9.9	33.5	56.6	Clay	99	
7	25- 50		26.7	27.4	45.9	Clay	80	85.7
	50-100		27.7	23.6	48.7	Clay	82	
	0-10		22.3	19.1	58.6	Clay	99	
8	10- 50		19.1	18.3	62.6	Clay	111	112.8
	50-100		17.2	13.2	69.6	Clay	117	
	0-15		9.90	33.42	56.68	Clay	98	
11	15-55		26.70	27.35	45.95	Clay	85	90.3
	55-80		27.72	23.50	48.78	Clay	88	
	80-100		19.95	26.00	54.05	Clay	98	
	0-20		25.9	23.5	50.6	Clay	82	
13	20-50		21.8	25.3	52.9	Clay	84	83.1
	50 -100		29.7	22.1	48.2	Clay	83	
	0-10		30.1	24.1	45.8	Clay	79	
16	10 -50		16.6	29.1	54.3	Clay	80	77.4
	50 -100		30	29.8	40.2	Clay	75	
	0-15		31.1	24.6	44.3	Clay	76	
18	15- 50		26.6	23.1	50.3	Clay	84	82.3
	50-100		31.5	28.3	40.2	Clay	83	
	0-20		19.4	29.8	50.8	Clay	88	
19	20- 45		24.6	24.3	51.1	Clay	87	94.3
	45-100		18.7	27.5	53.8	Clay	100	
	0-15		19.3	33.4	47.3	Clay	100	
22	15- 45		25.9	28.2	45.9	Clay	98	92.3
	45- 65		27.6	24.2	48.2	Clay	82	
	65 -100		22.3	27.5	50.2	Clay	90	
	0-15		30.1	24.1	45.8	Clay	95	
26	15-55		20.4	28.7	50.9	Clay	97	89.5
	55-100		28.8	29.5	41.7	Clay	81	

Table (1): cont.

28	0 -15		15.1	33.4	51.5	Clay	88	90.1
	15 - 45		24.7	29.4	45.9	Clay	86	
	45 -60		26.7	25.5	47.8	Clay	90	
	60 -100		18.9	26.6	54.5	Clay	94	
30	0 -20		30.2	26.1	43.7	Clay	80	82.4
	20 - 60		26.5	28.7	44.8	Clay	81	
	60-100		24.7	29.6	45.7	Clay	85	
32	0-25		30.3	25.1	44.6	Clay	83	84.4
	25- 65		25.6	27.6	46.8	Clay	84	
	65- 100		23.8	29.7	46.5	Clay	86	
35	0-15		15.1	34.4	50.5	Clay	90	89.5
	15-40		23.7	29.9	46.4	Clay	89	
	40-60		27.1	25.5	47.4	Clay	87	
	60-100		18.6	27.9	53.5	Clay	91	
36	0-15		13.9	30.5	55.6	Clay	94	91.5
	15-45		21.6	28.3	50.1	Clay	90	
	45-70		25.5	24.8	49.7	Clay	91	
	70-100		20.5	26.3	53.2	Clay	92	
41	0-20		21.9	18.5	59.6	Clay	102	112.4
	20-60		18.2	19.3	62.5	Clay	112	
	60-100		16.9	15.5	67.6	Clay	118	
42	0-10		20.3	19.1	60.6	Clay	106	114.6
	10-50		18.9	21.5	59.6	Clay	110	
	50-100		15.2	12.2	72.6	Clay	120	
44	0-10		30.1	24.1	45.8	Clay	79	77.4
	10-50		16.6	29.1	54.3	Clay	80	
	50-100		30	29.8	40.2	Clay	75	
48	0-10		20.3	19.1	60.6	Clay	99	113.7
	10-50		18.1	18.3	63.6	Clay	112	
	50-100		16.2	13.2	70.6	Clay	118	
49	0-10		21.3	18.1	60.6	Clay	104	114.8
	10-50		18.1	16.3	65.6	Clay	111	
	50-100		15.2	13.2	71.6	Clay	120	
50	0-20		19.4	19.1	61.5	Clay	106	115.6
	20-65		16.9	15.6	67.5	Clay	115	
	65-100		10.6	11.8	77.6	Clay	122	
51	0-15		19.8	20.5	59.7	Clay	108	117.2
	15-60		12.9	18.6	68.5	Clay	116	
	60-100		10.6	13.8	75.6	Clay	122	
53	0-10		21.3	18.1	60.6	Clay	104	114.8
	10-50		18.1	16.3	65.6	Clay	111	
	50-100		15.2	13.2	71.6	Clay	120	
54	0-10		21.3	18.1	57.5	Clay	90	86.1
	10-50		18.1	16.3	60.6	Clay	89	
	50-90		15.2	13.2	59.3	Clay	86	
	90-100		34.3	30.9	34.8	Clay	71	
55	0-10		20.3	21.5	58.2	Clay	90	97.9
	10-50		18.6	19.8	61.6	Clay	91	
	50-100		15.5	13.8	70.7	Clay	105	
56	0-20		20.6	17.8	61.6	Clay	108	118.2
	20-55		11.1	12.6	76.3	Clay	119	
	55-100		10.2	11.2	78.6	Clay	122	

Table (2): Grain size distribution and SP values of the soils outside the proposed rice belt

Profile No.	Depth cm	Grain size distribution			Soil texture	Saturation Percent (SP)	Weight average of SP
		Sand %	Silt %	Clay %			
3	00-10	41.4	24.3	34.3	Sandy clay loam	56	54.7
	10-65	45.5	20.8	33.7	Sandy clay loam	55	
	65-100	46.5	28.2	25.3	Sandy clay loam	54	
4	0-20	86.4	6.3	7.3	Loamy sand	20	19.2
	20-65	83.5	8.1	8.4	Loamy sand	19	
	65-100	86.1	6.8	7.1	Loamy sand	19	
5	0-25	46.4	23.3	30.3	Sandy clay loam	54	55.5
	25-70	43.5	21.8	34.7	Sandy clay loam	58	
	70-100	47.5	26.2	26.3	Sandy clay loam	53	
6	0-15	46.4	23.3	30.3	Sandy clay loam	55	57.8
	15-45	33.6	30.8	35.6	Clay loam	61	
	45-75	36.5	29.2	34.3	Clay loam	59	
	75-100	49.5	24.7	25.8	Sandy clay loam	54	
9	0-10	87.5	4.3	8.2	Loamy sand	20	19.1
	10-50	88.3	5.9	5.8	Gravelly sand	19	
	50-100	89.1	4.8	6.1	Gravelly sand	19	
10	0-20	46.9	22.6	30.5	Sandy clay loam	59	59.1
	20-65	43.1	24.6	32.3	Sandy clay loam	60	
	65-100	47.5	22.2	30.3	Sandy clay loam	58	
12	0-15	41.6	25.3	33.1	Clay loam	55	50.8
	15-45	41.3	26.9	31.8	Clay loam	52	
	45-100	63.7	13.8	22.5	Sandy clay loam	49	
14	0-15	41.6	25.3	33.1	Clay loam	60	45.6
	15-40	74.6	8.3	17.1	Sandy loam	53	
	40-70	71.7	13.8	14.5	Sandy loam	31	
	70-100	49.6	20.3	30.1	Sandy clay loam	47	
15	0-15	46.6	15.3	38.1	Sandy loam	61	38.4
	15-50	74.4	9.5	16.1	Sandy loam	30	
	50-75	73.7	12.8	13.5	Sandy loam	29	
	75-100	48.6	21.5	29.9	Sandy clay loam	46	
17	0-15	49.6	21.8	28.6	Sandy clay loam	50	27.3
	15-50	73.5	11.8	14.7	Sandy loam	28	
	50-75	85.5	5.9	8.6	Loamy sand	20	
	75-100	83.2	7.3	9.5	Loamy sand	20	
20	0-15	41.6	24.3	34.1	Clay loam	61	33.2
	15-40	74.6	9.3	16.1	Sandy loam	29	
	40-100	73.7	12.8	13.5	Sandy loam	28	
21	0-15	49.6	19.8	30.6	Sandy clay loam	56	33.2
	15-60	39.6	26.3	34.1	Clay loam	58	
	60-100	40.7	25.5	33.8	Clay loam	57	
23	0-15	19.9	31.5	48.6	Clay	79	51.3
	15-50	39.8	26.3	33.9	Clay loam	55	
	50-75	46.9	20.6	32.5	Sandy clay loam	54	
	75-100	75.7	10.8	13.5	Sandy loam	27	

Table (2): cont.

24	0-20	23.9	29.5	46.6	Clay	80	53.8
	20-70	40.9	26.3	32.8	Clay loam	60	
	70-100	75.7	10.8	13.5	Sandy loam	26	
25	0-20	74.6	10.8	14.6	Sandy loam	27	37.4
	20-60	47.9	20.3	31.8	Sandy clay loam	54	
	60-100	75.8	10.8	13.4	Sandy loam	26	
27	0-20	74.6	10.8	14.6	Sandy loam	27	23
	20-60	47.9	20.3	31.8	Sandy clay loam	54	
	60-100	75.8	10.8	13.4	Sandy loam	26	
29	0-15	76.3	9.1	14.6	Sandy loam	25	22.5
	15-60	75.5	10.7	13.8	Sandy loam	24	
	60-100	84.1	6.8	9.1	Loamy sand	20	
31	0-20	42.3	25.9	31.8	Clay loam	60	42.1
	20-55	41.6	26.3	32.1	Clay loam	59	
	55-100	83.1	7.4	9.5	Loamy sand	21	
33	0-20	75.3	8.1	16.6	Sandy loam	27	24.4
	20-80	76.7	9.1	14.2	Sandy loam	25	
	80-100	86.1	3.8	10.1	Loamy sand	20	
34	0-20	75.3	9.1	15.6	Sandy loam	26	22.7
	20-50	79.1	9.8	11.1	Sandy loam	25	
	50-100	86.6	4.1	9.3	Loamy sand	20	
37	0-15	51.6	18.8	29.6	Sandy clay loam	56	57.3
	15-60	35.2	25.7	39.1	Clay loam	58	
	60-100	40.8	25.9	33.3	Clay loam	57	
38	0-20	58.6	17.8	23.6	Sandy clay loam	54	29.5
	20-50	75.5	10.9	13.6	Sandy loam	26	
	50-85	78.1	9.8	12.1	Sandy loam	23	
	85-100	85.6	5.1	9.3	Loamy sand	19	
39	0-25	75.5	9.7	14.7	Sandy loam	27	24.9
	25-65	77.1	7.8	15.1	Sandy loam	27	
	65-100	85.6	4.5	9.9	Loamy sand	21	
40	0-20	66.8	12.3	20.9	Sandy clay loam	59	54.3
	20-55	42.2	20.7	37.1	Clay loam	65	
	55-80	61.6	15.8	22.6	Sandy clay loam	60	
	80-100	76.7	10.9	12.4	Sandy loam	24	
43	0-15	67.8	10.6	21.6	Sandy clay loam	61	47.8
	15-60	59.2	12.5	28.3	Sandy clay loam	64	
	60-75	68.6	11.8	19.6	Sandy loam	26	
	75-100	77.4	8.9	13.7	Sandy loam	24	
45	0-20	76.6	10.8	12.6	Sandy loam	25	23.8
	20-60	75.4	8.9	15.7	Sandy loam	26	
	60-100	84.9	5.4	9.7	Loamy sand	21	
46	0-15	75.3	10.5	14.2	Sandy loam	30	29.1
	15-65	68.7	20.1	11.2	Sandy loam	29	
	65-100	71.2	13.6	15.2	Sandy loam	29	
47	0-15	25.9	33.4	40.7	Clay	70	55.9
	15-45	47.2	22.3	30.5	Sandy loam	60	
	45-70	43.8	23.5	32.7	Sandy loam	63	
	70-100	57.2	24.6	18.2	Sandy loam	39	
52	0-15	47.6	22.7	29.7	Sandy clay loam	62	40.2
	15-50	63.5	19.4	17.1	Sandy loam	26	
	50-80	57.2	24.6	18.2	Sand	38	
57	0-20	97.1	1.1	1.8	Sand	20	18.6
	20-45	96.6	1.9	1.5	Sand	19	
	45-100	95.1	1.7	3.2	Sand	18	

Defining Soil Taxonomy of the Pro-Delta for rice belt cultivation

Based on physiographic features, physiochemical characteristics of soils with consideration of the meteorological conditions of the studied area, soil taxa of delineated Pro-Delta for rice belt cultivation are fitting the requirement to be Vertisols. Vertisols are highly recommended to be fully managed to fit required practices for aquatic rice cultivation based on their unique behaviour to the root zone, drainage condition, permeability and salinization process, (especially in the arid climate as in Egypt). The best case for managing these soils is to wet their strata to avoid the problem of soil shrinkage under the aridic moisture regime. As the water management for rice is fitting the most beneficial use of Vertisols, their soils are highly recommended for rice cultivation as formulating a potential adaptation between Vertisols behavior and rice cultivation practices. Rather potential adaptation is to solve the problems of salinity and sodocity, which are charactering Vertisols in some areas of the Pro-Delta in its northern portion. It is most probably that these problems can be easily treated once the Vertisols are consequently submerged by the high irrigation water requirements comparing to the other cropping patterns. In the current study four Vertisol families were identified in the Pro-Delta of River Nile in Table 3 and described as follows:

1) Typic Haplotorrerts, very fine
2) Typic Haplotorrerts, fine
3) Sodic Haplotorrerts, very fine
4) Halic Gypsitorrerts, fine

Delineated rice belt border

Rice belt area was delineated to be so easy in practice to trace its track and its limits (Figure 2). For this purpose, the residential blocks of villages and districts that are aligning and bounding the path of the rice belt were either located or nominated. Within this belt, the administrative boundaries of provinces is separating portions of this belt to be as sub units belonging parts in each province

Table (3): Soil attributes of the representative profiles for *Vertisols* categories in the Pro-Delta of rice belt cultivation

Profile No.	Depth (cm)	Horizon	Particle size distribution %			$CaCO_3$ g/kg	$CaSO_4.2H_2O$ g/kg	EC (dS/m)	SAR	Taxonomic class
			Sand	Silt	Clay					
A	0-25	Ap	20.6	19.1	60.3	30.2	9.1	2.2	11.8	
	25-65	Css	16.9	15.6	67.5	35.7	5.6	2.8	12.9	
	65-100	C1	15	11.8	73.2	39.1	10.4	3.1	10.7	
	100-150	C2	24.8	13.9	61.3	27.6	.19.3	1.9	13.0	*Typic Haplotorrerts, very fine, thermic*
B	0-30	Ap	20.6	19.9	59.5	28.2	8.5	2.3	12.3	
	30-65	Css	21.9	17.6	60.5	29.7	4.9	1.9	10.4	
	65-110	C1	15.6	13.2	71.2	31.1	8.5	1.8	11.5	
	110-150	C2	24.4	14.5	61.1	22.6	7.8	1.7	12.1	
C	0-30	Ap	8.8	23.9	45.6	11.6	3.2	3.2	11.5	
	30-70	Css	27.3	25.5	47.2	16.9	7.3	1.1	10.4	
	70-95	C1	24.9	21.6	53.5	22.5	6.4	1.5	8.3	
	95-150	C2	24.9	23.7	51.4	25.2	5.7	1.3	8.9	*Typic Haplotorrerts, fine, thermic*
D	0-25	Ap	19.3	33.4	47.3	13.4	5.8	0.9	7.2	
	25-65	Css	16.1	28.2	55.7	17.8	11.6	0.8	6.4	
	65-95	C1	27.6	24.2	48.2	16.3	3.2	1.1	8.6	
	95-150	C2	23.4	26.5	50.1	12.9	5.7	2.9	9.7	
E	0-20	Ap	21.3	18.1	60.6	13.5	2.1	3.7	16.8	
	20-75	Cn,ss	18.1	16.3	65.6	16.2	2.2	2.4	20.7	*Sodic Haplotorrerts, fine, thermic*
	75-105	C1n	15.2	13.2	71.6	19.6	2.5	3.8	15.6	
	105-150	C2n	15.9	17.9	66.2	27.9	3.4	2.5	17.8	
F	0-20	A	12.5	32.4	55.1	1.60	41.8	20.45	12.9	
	20-70	Cy,ss	27.8	27.3	44.9	2.00	12.9.	24.30	10.1	*Halic Gypsitorrerets, fine, thermic*
	70-110	Cy	26.8	24.5	48.7	1.20	62.42	35.62	9.2	
	110-150	Cg	18.3	25.2	56.5	1.20	41.2	22.45	10.3	

A and C = Master horizons, n = accumulation of exchangeable sodium. P = *Tillage or other* mechanical disturbance,
ss = presence of slickensides, y = the accumulation of gypsum

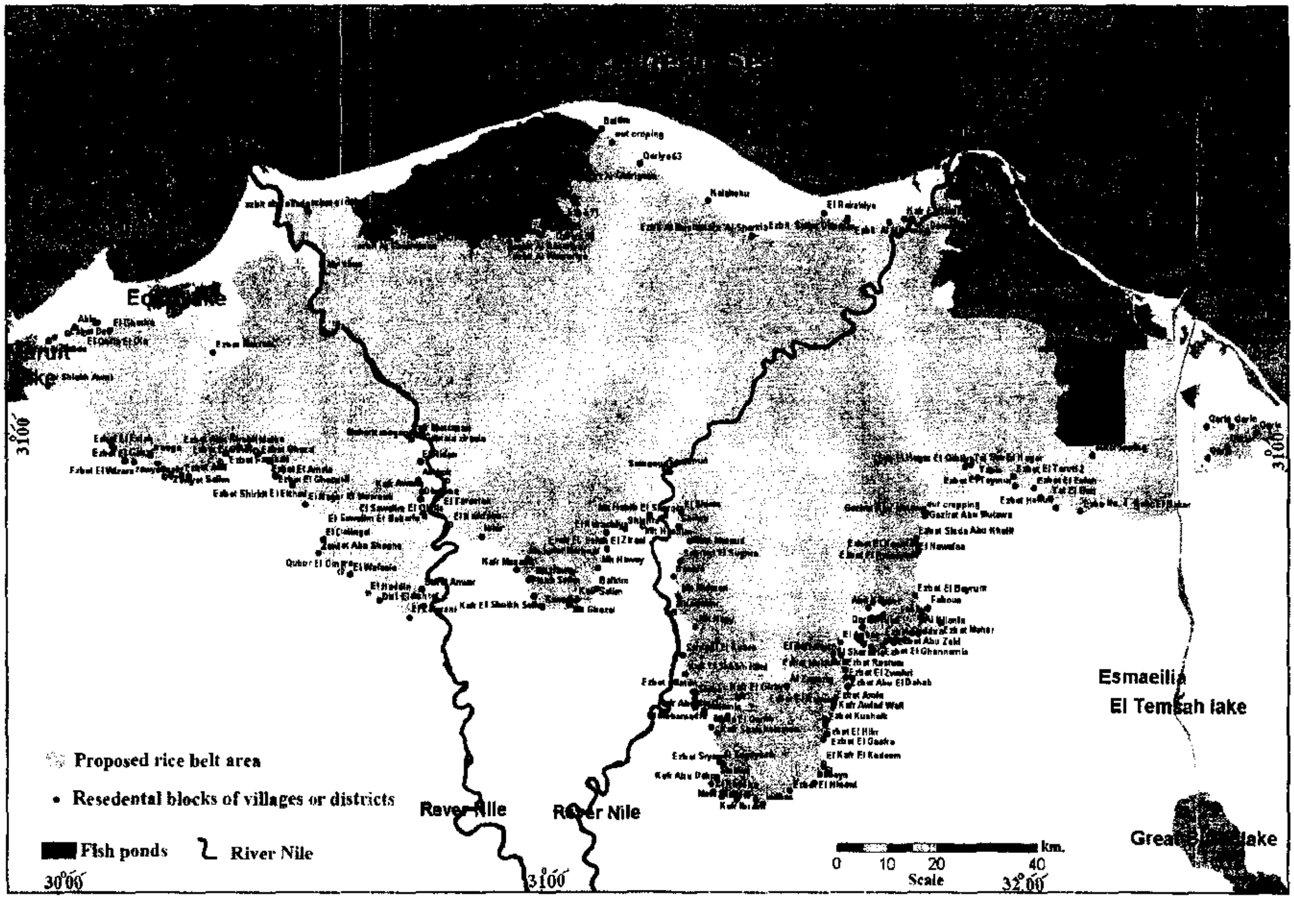

Figure (2): The delineated rice belt area in the River Nile Pro-Delta with the bounding residential block

Estimated area for cropping rice within the rice belt region

Estimating land cover components in rice belt area is an important base in order to know the actual area that can be used for rice cultivation in that belt. The other land cover classes were excluded from the total area of the delineated rice belt. First step was for excluding the land cover classes of roads, railways and water flows of irrigation and draining canals. They were delineated, buffered and cut out from the image. Accordingly, the spectral signatures of the landscape features were limited on image mask as urban areas horticultural space, annual crops and fish ponds. The image mask was classified by the nodule of un-supervised classification. The total area of the proposed rice belt cultivation was estimated at 2851581 feddans (1197201 hactares) while the annual crops were estimated as a portion of the total area equivalent to 1782322 feddans (748874.8 hactares). This area of the annual crops within the Pro-Delta that is proposed for rice belt cultivation is the available land spaces that can be managed for rice cultivation. According to the annual requirement of rice products, this specified area can be totally or partly managed for the aquatic rice cultivation. Table 4 shows the spatial distribution of the different land cover elements, while Figure 3 shows the geographical distribution of them.

Table (4): Different land cover distribution within the proposed rice belt area

Land cover class	Area per feddan	Area per hectare	%
Horticultural trees	539838	226822.7	18.9
Annual crops	1782322	748874.8	62.5
Urbanized areas	318471	133811.3	11.2
Roads and canals	124950	52500	4.4
Fish ponds	86000	36134.45	3.0
Total area of rice belt	2851581	1198143	100

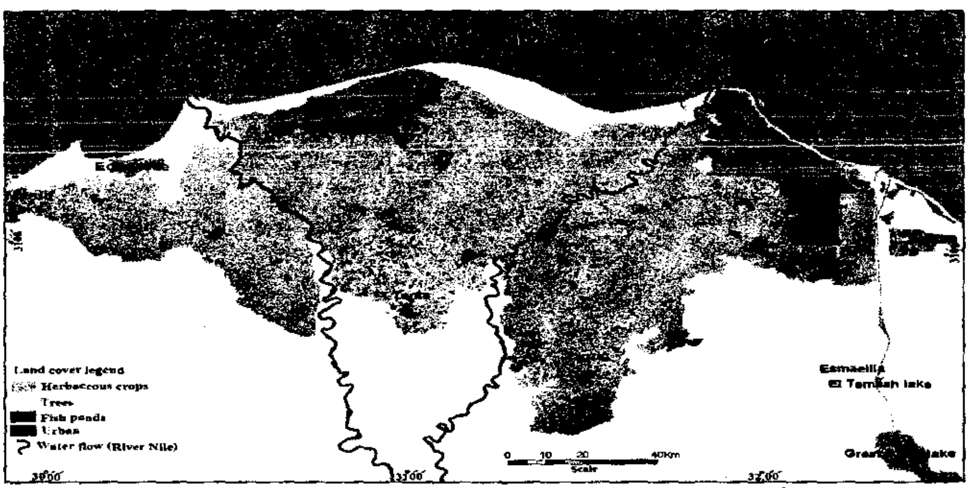

Figure (3) Different land cover distribution within the proposed rice belt area

CONCLUSION AND RECOMMENDATIONS

It is highly recommended to grow the aquatic rice in the River Nile Pro-Delta of Vertisols that have more water-soil saturation percent comparing to the surrounding other soils. The recommendation will lead to spare quantities of water resources as soils in that belt hold water quantities equivalent to more than two and half times (SP 96.8 / SP 37 = 2.6). Considering the proposed rice belt cultivation to have the priority for developing surface irrigation practices and modifying the surface irrigation outside this region to other types of irrigation leading to the provision of other amounts to be saved of water resources. Growing aquatic rice in the Nile Pro-Delta help for integrating hydraulic pressure that face the leakage of saltwater from the sea, protecting the Nile Pro-Delta from erosion or salinization. Improving the land quality of fish ponds within the Pro-Delta to be introduced for rice cultivation. Supporting farmers to produce cotton and maize to be competitive profitable compared to revenue obtained from rice cultivation taking into account that the unit of irrigation water for cotton crop is better from an economic standpoint compared to rice products. Find progressive solutions for industrial recycling of rice waste straw to avoid problems resulting from burning these wastes and could generate additional revenue for its cultivation. Delineating rice belt cultivation is a positive step for spare amounts of water resources but based on that, more studies still required. It is recommended to formulate these studies to realize the best values of spared water volume considering extra parameters as climatic factor, empirical results of irrigation water requirements and data of previous yearly rice area cultivation for specific duration.

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تحديد نطاق زراعات الأرز فى دلتا النيل من تربة الفيرتيسول بإستخدام بيانات الإستشعار عن بعد للقمر الصناعى المصرى إيجيبت سات -١

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الملخص العربى :

تحديد نطاق زراعات الأرز يمثل أهمية كبيرة لمنطقة شمال الدلتا ، حيث يهدف تحديد هذا النطاق بشكل أساسى لتوفير جزء من الموارد المائية بالمنطقة كما يهدف كذلك لإحداث نوع من توازن الضغط المائى لحماية سواحل الدلتا من خطر التآكل بفعل مياه البحر. منطقة شمال الدلتا تميز بشكل عام بقوام تربة ثقيل مع قدرة عالية على الإحتفاظ بالمياه كما يدل نسبة تشبع التربة بالمياه (SP) حيث تراوحت نسبة التشبع (SP) لكل قطاع تربة من ٧٧,٥ إلى ١١٨,٢ سم^3/ ١٠٠جم بمتوسط ٩٦,٨ سم^3 / ١٠٠جم وذلك فى مناطق زراعة الأرز . المناطق المحيطة بمناطق زراعات الأرز تتميز التربة فيها بقوام أقل حيث يتراوح نسبة التشبع لكل قطاع تربة من ١٩,١ إلى ٥٩,١ سم^3/ ١٠٠جم بمتوسط ٣٧ سم^3/ ١٠٠جم ، ومن المتوقع زيادة معدل فقد المياه عندما يتم زراعة الأرز خارج النطاق المذكور حيث يمثل معدل إحتفاظ التربة بالمياه داخل حزام الأرز بأراضى فيرتيسول . يعتبر غمر الطبقة السطحية من تربة فيرتيسول بالمياه من أفضل الطرق لعلاج مشاكل التمدد والملوحة والقلوية ، كما يتميز محصول الأرز بقدرة عالية على التأقلم مع هذا النوع من التربة بدرجة تتفوق على كل المحاصيل الأخرى .

النطاق الذى تم تحديده كنطاق صالح لزراعة يمثل مساحة إجمالية قدرها 2850479 فدان (١١٩٧٢٠١,٣ هكتار) مقسمة إلى ٥٤٠٢٠,٧ فدان (٢٢٦٨٨,٧ هكتار) محاصيل بستانية و ١٧٨٣٠٣٥ فدان (٧٤٨٨٧٤,٨ هكتار) محاصيل عشبية فى حين تقسم الأراضى الغير

منزرعة فى داخل هذا النطاق إلى مناطق عمرانية تمثل ٣١٨٥٩٨,٣ فدان (١٣٣٨١١,٣ هكتار) وطرق ومجارى مائية تمثل ١٢٥٠٠٠ فدان (٥٢٥٠٠ هكتار) ومزارع سمكية تمثل ٨٣٧٩١,٤ فدان (٣٥١٩٢,٤ هكتار). هذا و قد تم تحديد نطاق زراعات الأرز أو حزام الأرز بمناطق تربة الفيرتيسول التى تم تصنيفها من بيانات الأقمار الصناعية كمناطق محاصيل عشبية.

يمكن من خلال تتبع الحزام المقترح لزراعات الأرز التفرقة بين نظامين للرى هما نظام الرى السطحى والذى يلزم تطبيقه داخل نطاق حزام الأرز ونظم الرى الحديثة كالرش والتنقيط التى يمكن تطبيقها فى المناطق الأخرى خارج نطاق الحزام المقترح.