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TERRAIN ANALYSIS AS A BASE OF SOIL PRODUCTIVITY IN TUSHKA BASIN, UPPER EGYPT.

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ABSTRACT

One of the largest and most important projects in Egypt is Tushka Project that lies in the western side of Nasser lake ,Upper Egypt .The project area covers about 1.5 million feddans, of which about 500,000 feddans will be selected for agricultural uses. The selected area will be irrigated from two sources of water (ground& flooded water). The ground water will be the main water resource for irrigation followed by ,the Nile water during the high flooding seasons. Several attempts were carried out to select the suitable areas for agricultural purposes using the conventional methods. Due to the high cost and time consuming of the ground survey in such an extremely arid land, remote sensing and Geographic Information System (GIS) have to be used for landuse planning in Tushka area. Multi-sensors remotely sensing techniques were applied to map the land resources of the project area. Landsat thematic mapper collaborated with Spot panchromatic imageries were analyzed to define the different mapping units of the area. Data merging techniques were performed to identify the physiographic units of the studied area accurately. Eighteen physiographic units have been recognized i.e. peniplains, footslopes, alkali flats, mesas and buttes ,ridges, chain of barchans ,hills, hilly land ,alluvial fans, plains covered with desert pavement , dry valleys, escarpment, decantation basins, plateau, inclined granitic basement, clusters of basalt and pediment. Physiographic units were integrated with the other parameters for identifying the soil type. Soil productivity classification was applied to evaluate the potentialities of land resources for agriculture. Soil productivity classes range between grade III and VI. On the other hand, the collected surface and ground water samples were analyzed and classified as C1-S1 for the surface water which is suitable for most crops and C3-S1 for the ground water samples which is suitable for salt tolerant crops.
Keywords: Physiography, soils ,water , productivity ,remote sensing and GIS.

INTRODUCTION

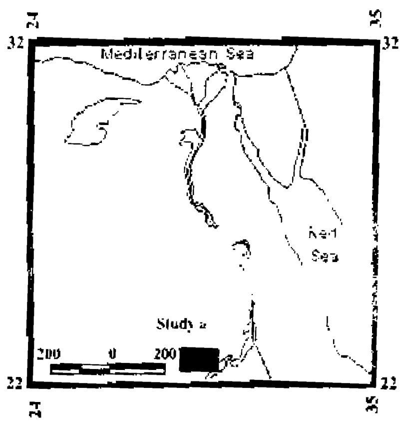
The main policy of the Egyptian government is to establish new agricultural communities in the desert areas. One of the largest and most important projects in the Egyptian desert is Tushka Project that lies in the western side of Nasser lake ,Upper Egypt. The project aims at cultivating about 500,000 feddans with different types of field crops, vegetables and orchards.

Many officials affirmed that they had no doubt regarding the economical feasibility of Tushka Project .The project, initially launched as the Sheikh Zayed Canal ,which was first contemplated during the sixties, with the object of using part of the water retained by the High Dam in cultivating and reclaiming all arable land in the Western Desert .The current project (the project of the nineties) is different from the earlier one that was presented by the Desert Reconstruction Authority during the sixties, so that the latter was confined to the cultivation of 500,000 feddans out of the total area of the Tushka depression which covers 1.5 million feddans. According to the earlier project, the Tushka spillway canal was the main channel for the New Valley Canal .As to the current project, the whole area of Tushka Depression can accommodate the overflowing water when it reaches the level of 178 meter in front of the High Dam.

Discription of the study area.

Location.

Tushka basin lies in the farthest Upper Egypt to the west of Nasser lake. It takes a rectangular- shape, which is around 110 km-width and run from south to north ,starting from the northeast of Tushka overflow canal, it extends westward over a distance of about 250 Km. The study area lies between the latitudes 22° 30' and 23° 00' N and the longitudes 30° 40' and 31° 30' E. Figure (1) represents location of Tushka project. On the other hand figure(2) shows the investigated area as a part of Tushka project, which is represented by the areas that will be irrigated from branches 3 and 4 of El-Shiekh Zayed canal.



Figure(1):Location of Tushka project.

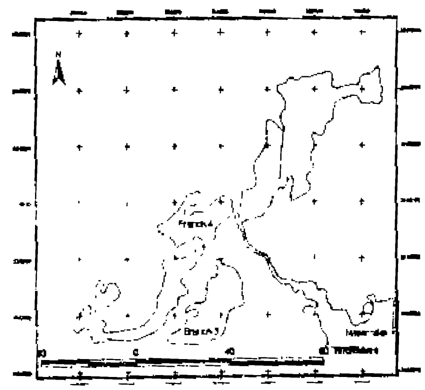


Figure (2) The investigated area (branches 3&4).

MATERIALS AND METHODS

The methods used in this study can be broadly listed under the following :-

1-The land survey was based on the analysis of satellite data via Landsat TM-5 and SPOT images with the aid of topographic maps at a scale of 1:5000.

2-The multi-sensors (TM&SPOT) data have been merged in order to produce one image with multi-spectral bands(TM) and 10 meter spatial resolution (SPOT).Paths and rows of these scenes are illustrated in table (1)

Table (1) Paths and rows of Landsat 5 and SPOT images .

Sensor	Spatial resolution/m	Path	Row
Landsat5- TM 1995	30	175	44
SPOT Scene 1	10	115	304
SPOT Scene 2	10	116	304
SPOT Scene 3	10	116	305

3-Main physiographic units have been interpreted, delineated and digitized on screen (heads up) using ERDAS imagine 8.5 software.

4-Field studies and ground truth were carried out to identify the physiographic units and to examine the reality of the interpretation .

5-Eighteen soil profiles represent the different mapping units were dug for the purposes of morphological description and soil sampling.

6-Laboratory analyses includes the following items:-

a-Soil physical &chemical analyses i.e. particle size distribution, saturation percentage, soluble cations and anions , EC, O.M, pH and $CaCO_3$, Dewis and Feritas, (1991)

b-Ten surface and wells water have been sampled and analyzed including soluble cations and anions, pH, EC according to Dewis and Feritas, (1991)

7-Matching physiographic units, morphological description and laboratory analyses ,soil map was obtained according to the Soil Survey Staff,1999.

8-Soil productivity classification was carried out using a parametric method for land evaluation proposed by Riquier *et al.*(1970).

9-GIS packages (ARC GIS 8.1) were used for the following items:-

a-Rectifying, transforming, projecting the vector layers derived from digitizing TM/SPOT data fusion image.

b-Making topology for identifying the spatial relations among the different units.

c-Producing the final map layouts of physiographic &soil and productivity maps.

RESULTS AND DISSCUSSION

Multisensor image merging.

Many applications of digital image processing are enhanced through the merger of multiple data sets covering the same geographic area (Lillesand and Kiefer,1994). Thematic mapper (TM) and SPOT images covering the study area have been merged and resulted in a composite image product that offers greater interpretability than an image from any one sensor alone as shown in figure (3).

Figure (3) :Data merge using TM &SPOT images.

Physiography and soils.

Visual interpretation using digitizing on screen (heads up) supported with thematic maps and field survey was performed for generating the different mapping units of the merged image that was produced from Landsat TM and SPOT panchromatic .The interpretation resulted in the following physiographic units:

-1-Peniplains.2- Footslopes.3- Alkali flats.4- Mesas and buttes.5- Ridges.6-Chain of barchans.7- Isolated hills.8-Alluvial fans .9-Sand plain with desert pavement.10-Dry valleys.11-Escarpments.12-Decantation basins.13-Plateau.14- Inclined granitic basement .15- Pediment. 16-Gravely plain. 17-Clusters of basalt and 18-Hilly land .

Physical and chemical properties of the soils belonging to the investigated area as shown in tables (2,3&4) indicated that ,there are two soil orders i.e.1-Entisols and 2- Aridisols. Matching the physiographic units ,profile description ,field survey and soil characteristics ,physiography and soils mapping units could be identified as shown in figure (4):

Soil productivity.

Soil productivity is the capacity of a soil for producing a specified plant or sequence of plants under a physically defined set of management practices,(Soil Survey Staff,1951).An attempt has been made to evolve a mathematical formula expressing productivity as a resultant of the various Factors that considered following STORIE'S method of calculation. A parametric method for land evaluation has been proposed by Riquier *et al.*(1970).

Table (2) :Physical analyses of Tushka area branches 3 &4

Profile No	Depth cm	Particle size distribution						CaCO3%	T.Cl	Per	E.C	W.P	O.M %
		Clay	Silt	F.S	M.S	C.S	V.C.S						
P1	0-15	[illegible]	[illegible]	27.9	30.1	8.1	[illegible]	3.2	S.L	[illegible]	[illegible]	[illegible]	[illegible]
	15-35	27.9	24.1	18.2	21.8	6.4	1.6	1.9	S.C.L	0.684	23.8	7.9	0.9
	35-60	56.1	25.9	7.3	7.7	1.9	1.1	0.95	C	0.112	38.8	12.8	1
	60-120	22.9	25.1	20.2	24.8	5.6	1.4	1.9	S.C.L	[illegible]	21.8	6.9	0.8
P2	0-7	[illegible]	[illegible]	34.6	54.1	10.6	1.1	8.6	S	11.6	7.9	2	0.3
	7-22	10.0	8.0	28.2	44.6	8.1	1.1	7.1	L.S	3.2	9.8	3.8	0.5
	22-90	6.1	7.9	34.2	43.5	7.3	1.0	2.4	L.S	3.9	9.8	4.2	0.4
P3	0-5	1.7	1.1	37.1	52.8	3.1	4.2	12.4	S	11.8	8.4	2.4	0.1
	5-60	8.1	7.9	32.1	42.9	6.8	2.2	0.95	L.S	2.9	9.6	2.9	0.3
P4	0-15	1.5	1.1	41.2	40.2	13.9	2.1	2.7	S	13.4	7.4	2.2	0.1
	15-30	1.7	1.1	41.2	40	13.5	2.5	3.8	S	2.14	16.3	4.9	0.2
P5	0-10	13.1	10.9	25.9	35.3	12.8	2	11.4	S.L	1.98	17.2	5.9	0.3
	10-30	6.2	9.8	33.1	40.1	8.7	2.1	5.2	L.S.	4.3	13.4	4.2	0.1
	30-150	16	10	27.2	36.1	8.7	2	0.95	S.L	2.24	17.6	5.8	0.2
P6	0-15	6.2	10	32.8	39.2	9.4	2.4	1.9	L.S	4.7	9.9	3.2	0.3
	15-30	12.1	15.9	26.3	36.2	7.2	2.3	10.5	S.L	1.99	16.9	5.7	0.4
	30-80	14.2	18.1	26.2	32.2	7.1	2.2	14.3	S.L	2.11	17.2	5.2	0.5
P7	0-10	12.1	13.9	27.5	35.8	8.1	2.6	9.2	S.L.	2	16.9	4.9	0.4
	10-17	22	16	23.1	31.5	5.2	2.2	4.8	S.C.L.	0.998	24.8	7.6	0.6
	17-95	12	16	28.2	35.1	6.5	2.2	5.2	S.L	1.84	17.2	5.2	0.3
P8	0-5	10.1	5.9	32.6	39.5	9.5	2.4	1.9	L.S.	3.9	12.4	3.9	0.1
	5-20	16.1	13.9	26.7	33.5	7.5	2.3	5.7	S.L.	1.78	16.7	4.8	0.3
	20-90	18.3	17.7	26.1	29	6.7	2.2	4.8	S.L.	1.84	19.9	5.7	0.4
P9	0-5	14.1	19.9	25.9	29.4	7.1	3.6	6.2	S.L.	1.92	16.6	5.2	0.3
	5-15	18.3	15.7	25.8	29.5	7.2	3.5	3.8	S.L.	1.14	15.8	5.8	0.2
	15-120	20.2	23.8	21.8	24.1	6.9	3.2	4.3	S.C.L.	1.25	17.6	4.2	0.4
P10	0-30	10.5	13.5	30.2	35.5	8.1	2.2	6.7	S.L.	2.3	17	3.4	0.1
	30-60	22.9	25.1	19.5	23.9	6.3	2.3	1.9	S.C.L	0.948	20.6	7.8	0.5
	60-130	30.1	27.9	14.3	19.2	6.4	2.1	0.95	C.L.	0.524	25.1	7.9	0.6
P11	0-3	1.1	2.8	25.1	52.8	16.1	2.1	10.5	S.	13.6	9.9	2.3	0.1
	3-30	8.1	5.9	33.7	38.7	11.2	2.4	5.2	L.S	3.12	12	3.4	0.3
	30-120	6.2	5.8	32.2	39.3	12.2	2.3	6.6	L.S	3.1	14.2	3.9	0.2
P12	0-5	1.1	2.2	35.7	51	7.2	2.8	15.2	S.	14.5	9.9	2.8	0.1
	5-30	8.9	5.1	32.4	37.7	13.1	2.8	6.7	S.L.	14.6	10	2.6	0.3
	30-120	8.9	6	32.2	36.1	14.1	2.7	8.6	S.L.	4.2	14.2	3.4	0.4
P13	0-5	1.6	3.2	25.3	50.2	16.3	3.4	11.9	S	15.4	9.8	2.4	0.1
	5-35	6.1	7.9	32	36.9	14.2	2.9	2.8	S.L.	3.8	12.2	3.8	0.3
	35-100	10.5	5.5	32.1	34.6	15.2	2.1	2.8	L.S.	3.19	14.7	4	0.2
P14	0-10	0.8	1.3	23.5	60.1	11.9	2.2	10.9	S	16.72	5.9	1.1	0.1
	10-30	0.8	1.8	29	56.2	10.1	2.1	4.2	S	15.24	7.4	1.6	0.2
	30-150	1	1.4	40.2	46.3	9.1	2	2.4	S	16.17	8.1	1.7	0.1
P15	0-5	0.7	1.9	19	56.2	20.1	2.1	20.6	S	15.6	7.4	1.7	0.1
	5-30	1.3	2.6	15.3	52.6	25.9	2.3	15.5	S	13.6	9.9	2.3	0.1
P16	0-5	0.8	1.8	29	56.2	10.1	2.1	4.2	S	14.21	7.9	1.6	0.1
	5-15	1.2	2.7	25.3	52.6	15.9	2.3	10.5	S.	13.6	9.9	2.3	0.1
p17	0-7	0.7	2	28.9	56.3	10	2.1	11.5	S	15.24	7.5	1.5	0.1
	7-30	1.1	2.8	25.1	52.8	16.1	2.1	13.6	S	12.9	8.5	2.1	0.1
P18	0-5	27.8	24.1	17.1	22.8	6.3	1.9	15.2	S.C.L	0.684	23.8	7.9	0.9
	5-50	56.3	25.7	7.3	7.7	1.9	1.1	9.1	C	0.112	38.8	12.8	1

Abbreviations. T.Cl (Texture class) S (Sandy) .S.L. (Sandy loam)
S.C.L. (Sandy clay loam) . L.S. (Loamy sand) S.L. (Sandy loam) .C (Clayey)

Table (3): Chemical analyses of Tushka area (branches 3&4)

Profile No.	Depth cm	S.P	pH(1:2.5)	EC(dS/m)	Soluble cations meq/l Ca	Mg	Na	K	Soluble anions meq/l $CO_3^=$ & HCO_3^-	Cl	$SO_4^=$
P1	[illegible]	33	7 1	[illegible]	26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	15-35	43	7 3	8.3	20	2.0	42.0	0.8	1 4	4	59.2
	35-60	93	8 2	9.0	14 9	2.3	81	0 4	1 7	7 2	89.7
	60-120	43	7 8	7 4	42.6	28	434.3	4 3	1 3	254	254
P2	[illegible]	20	[illegible]	1 4	6.4	1 7	5 7	0 6	2 1	9	3.3
	*7-22	23	7 2	3.8	22.3	5	10	1 8	1.0	5	33.11
	22-90	21	7.3	5.1	19.2	8.1	29.5	1 4	0.9	9.6	52.8
P3	0-5	20	7 3	2 0	5 4	1 8	2.5	0 5	2 1	2	6 1
	*5-60	20	7.5	2.8	4.8	1 8	11 3	0 4	1 0	8.5	10 8
P4	0-15	18	7.3	1 8	10.8	1.5	5.2	1	0.9	2.5	14.88
	15-30	30	7.4	2.9	13	1.4	16	0.5	0 9	8	22
P5	0-10	23	7 6	5.3	22.3	4.3	27 3	1 53	0.8	6	48 6
	*10-30	22	7.4	5.7	17	9.3	43	1 8	0.9	9	61.2
	30-90	33	7 1	8	35.1	10	25	1.1	0.6	19	52
P6	0-15	22	7 9	8.6	28 7	9.7	30	1.5	1.9	8 5	59.5
	15-30	24	7.3	10 7	36.2	21	56	0 9	0 7	58	55 8
	30-80	23	7.9	10.8	36.2	21	58	0.9	0.7	58	55.8
P7	0-10	27	7.2	5.2	27.7	9.7	20	1 5	0.9	8	52
	*10-17	44	7 4	6.5	41.5	17	87	1.3	1.3	51	74.6
	17-35	31	7 5	8 0	46.8	9.8	146 7	1	1 0	91	112.3
P8	0-5	20	7.8	11.5	29.8	11	100	1.7	1.2	43	97 87
	*5-20	29	7.9	20.2	55.3	15	408.6	2	0.8	440	40.5
	*20-90	34	8.2	20.0	42.6	5.9	500	0 9	1.2	290	258.2
P9	0-5	30	7 8	6.5	19.2	9 1	45.8	1 4	1 2	5	69.27
	*5-15	28	8.1	9.7	36.2	6.2	144.5	1.9	1 1	80	107 7
	15-120	28	8.0	12.0	44.7	34	177.3	1 1	0.9	142	114.3
P10	0-30	22	7.9	5.1	10.84	7.6	31.2	1.6	10	6	43.99
	30-60	24	7 8	37 6	36 2	6.2	144.5	1 9	1 1	80	107 7
	60-130	48	8.2	15.3	40	63	407.7	2.1	2.7	350	160
P11	0-3	20	8.1	3.21	17	5.2	11.6	1.1	1 3	5	28.63
	*3-30	22	8.2	2.13	2.1	0.9	18.5	1.9	1.6	4	18 48
	30-120	23	8.3	2 65	6.5	3.1	14 7	2	1.5	4.5	22.3
P12	0-5	21	7.8	1.49	6.4	1 7	6.6	0.8	1.6	3	10.7
	*5-30	22	7.9	0.85	3.2	0.8	4	0.5	1 1	3	4.4
	30-120	23	7 9	0.59	1.6	0.9	3.2	0.2	2.0	0.5	3.4
P13	0-5	21	7 6	2.6	10	6 5	9	0 9	0.9	5	20.5
	*5-35	24	7 9	5.3	13.8	5.4	40.1	1 1	1 1	7	52.28
	35-100	23	7.8	8.2	43.6	17	60.5	1.5	0.7	47	74.9
P14	0-10	23	7 8	2.0	8.5	3.6	7.5	0.5	1.3	3	15.8
	*10-30	19	7 5	4.3	10	5	27	1 2	1 2	12	30
	30-130	17	7.9	6.4	25	7.2	30	0.8	1.3	29	33.7
P15	0-5	18	7 9	2.1	10 8	3.8	5	1	4.2	4	12.2
	*5-30	19	7 8	2 7	4.8	4.9	17 3	0 4	1 0	10 5	15.8
P16	0-5	17	7 8	18.0	46.8	9.8	148.7	1.0	1.0	91	112.3
	*5-15	19	7 8	35.6	55.3	15	408.6	2.0	0.8	440	40.5
P17	0-7	18	8.1	2.3	43.5	8.9	145.3	1	1.0	85 4	112.3
	*7-30	20	8.2	2 1	51 9	16	403.2	2 2	0 8	432 3	40.5
P18	0-5	[illegible]	7.9	55.1	120.1	92	1131	4.0	46.2	1160	120.4
	*5-50	66	8.1	35.6	65.3	15	709	2.0	0 8	740	40.9

Table(4) Physiography and soils of the investigated area.

Mapping units	Terrain origin and main soil characterization		Soil Taxonomy
	Physiography	Soils	
Sf	Spillway flood coast: Flat to almost flat terrain recently formed by flood deposits.	Soil texture has alternative pattern of sedimentation weak to moderate subangular blocky structure Few shale formations & Few mottles of iron oxide were noticed during *profile* description Soils are represented by profile No 1	*Typic Torrifluvents*
Sc Sd	Sand flats (covered by dominant desert pavement)* Sand flats (covered by Common desert pavement)** Aeolian deposits originated mainly by the wind action. Parent material is Nubian sand stones	Flat to almost flat sandy to loamy sand soils ,single grains to weak subangular blocky structure Soils are characterized by dominant and / or common desert pavement of basalt soils are represented by profiles (2,8)* & (3,13,14)** respectively	*Typic Torripsamments*
Sp	Sandy plains Characterized by flat surface and the occurrence of some short, shallow and blind dry valleys Some scattered hills are spreading over these plains resulting in existence of some gravels	Soil texture is sandy to sandy clay loam. Soil depth is deep(120 cm).Structure is single grains to weak subangular blocky $CaCO_3$ content is moderate and decrease irregularly with depth.. Soils are represented by profiles (9,11&12).	*Typic Torripsamments*
Cb	Clusters of basalt :Denuded igneous rock in the shape of clusters with discontinuous appearance over the sand strips	Undulating surface originated by wind action filling the gaps among the denuded basaltic rocks end forming sand sheets with different depths .Soil texture is sandy loam single grains to weak subangular blocky $CaCO_3$ content increase sharply with depth Soils are represented by profile No.6.	*Typic Torripsamments*
Af	Alluvial fans: originated from accumulation of debris brought down by gravity and / or by streams debouching in the plains and spreading out in the shape of fans	Texture is sandy loam to sandy clay loam Structure is weak subangular blocky $CaCO_3$ content decreases with depth soils are represented by profile No *7*	*Typic Torrifluvents*
Db	Decantation basins · Low -lying land ,almost flat and covered by a layer of desert pavement and debrises. These basins are originated from tectonic movements.	Texture is sandy loam to sandy clay loam Structure is platy $CaCO_3$ content decreases with depth Salic horizon occurs in these soils These soils are represented by profile No 10	*Typic Haplosalids*
Gp	Gravely plain . originated from the repeating cycle of water erosion on uplands and deflation process that left gravels and stones on the surface	Low lying sandy soils. Gravels and stones occur on the surface Depth is shallow and restricted by bed rock. Texture is very gravely sand Soils are represented by profile No 4	*Lithic Torriorthents*
Dv	Dry valleys. Cradle shape originated by water erosion during the flashfloods that occur rarely in the area The valley bottom has gently sloping while the valley side is sloping to steeply sloping terrain form frequently concave shape	Soils have been transported by sheet wash. Deep soil profile (150 cm) differs between sandy loam and loamy sand. Structure is week subangular blocky Lamella phenomena was noticed indicating the different age of the three successive layers. Soils are represented by profile No 5	*Typic Torrifluvents*
Pp	Peneplains extensive land area of very low relief produced in the ultimate stage of a normal cycle of sub aerial erosion. **(Douglas,1984)**	Low lying soils representing a very shallow sandy plain . restricted by lithic contact at 30 cm of the soil surface more than 5 % of rounded nodules of $CaCO_3$ were recgnized during profile description. Profile No 15 represents these soils	*Lithic Haplocalcids*

Table (4) cont.

Mapping units	Terrain origin and main soil characterization		Soil Taxonomy
	Physiography	Soils	
Al	Alkali flats: low-lying terrain in comparison with the surroundings originated mainly from discontinuous precipitation and evaporation process resulted in salt efflorescence on the surface with hexagonal cracks	Surface is almost flat and covered by debrises. Texture is sandy clay loam to clayey. Structure is platy. $CaCO_3$ content *decreases with depth*. Salic horizon was identified. These soils are represented by profile No 18	*Typic Haplosalids*
Pd	Pediment: *gently inclined erosion surface of* low relief typically developed in arid or semiarid regions at the foot of receding mountain slope. **Van Zuidan,R.A.(1978).**	low lying soils having a very shallow sand mantle. Texture is sandy single grains. Common concretions of $CaCO_3$ were identified during profile description. Profile *Soils are represented by No 17*	*Lithic Haplocalcids*
Pl	Plateau: This terrain is higher than the surrounding land-*scape at least from three sides*. *It* has a table surface and is composed mainly from lime stone and dolomite interlayer with layers of shale.	No soil profile was developed	-
Es	Escarpments: Very steep or near vertical faces which *have either smooth or irregular* parallel drainage patterns.	No soil profile was developed	-
Hi & Ih	Hilly land &Isolated hills. They are represented by domes and cones shapes and composed mainly of *basaltic rocks. They are* formed when footslopes finally cut through mountain ranges and intersect each other leaving a few isolated residual knobs of bedrocks.	No soil profile was developed	-
Br	Chains of barchans. Crescent dunes with leeward *pointing horns*. The slip face lies between the horns and recognized as continuous chain west of the study area.	No soil profile was developed	-
Ri	Ridges: represented by 1-*Cuestas,Hogbacks,and Dyke* like ridges.	No soil profile was developed	-
Mz	Mesas and buttes: Mesas are structurally controlled dissected plateau ,while buttes have the same formation of the mesas but *the diameter of the cap rock is less* than the height of the hill above the surrounding terrain.	No soil profile was developed	-
Dg	Inclined granitic basement. Discontinuous terrain appears as inclined surfaces and covers a large area.	No soil profile was developed	-

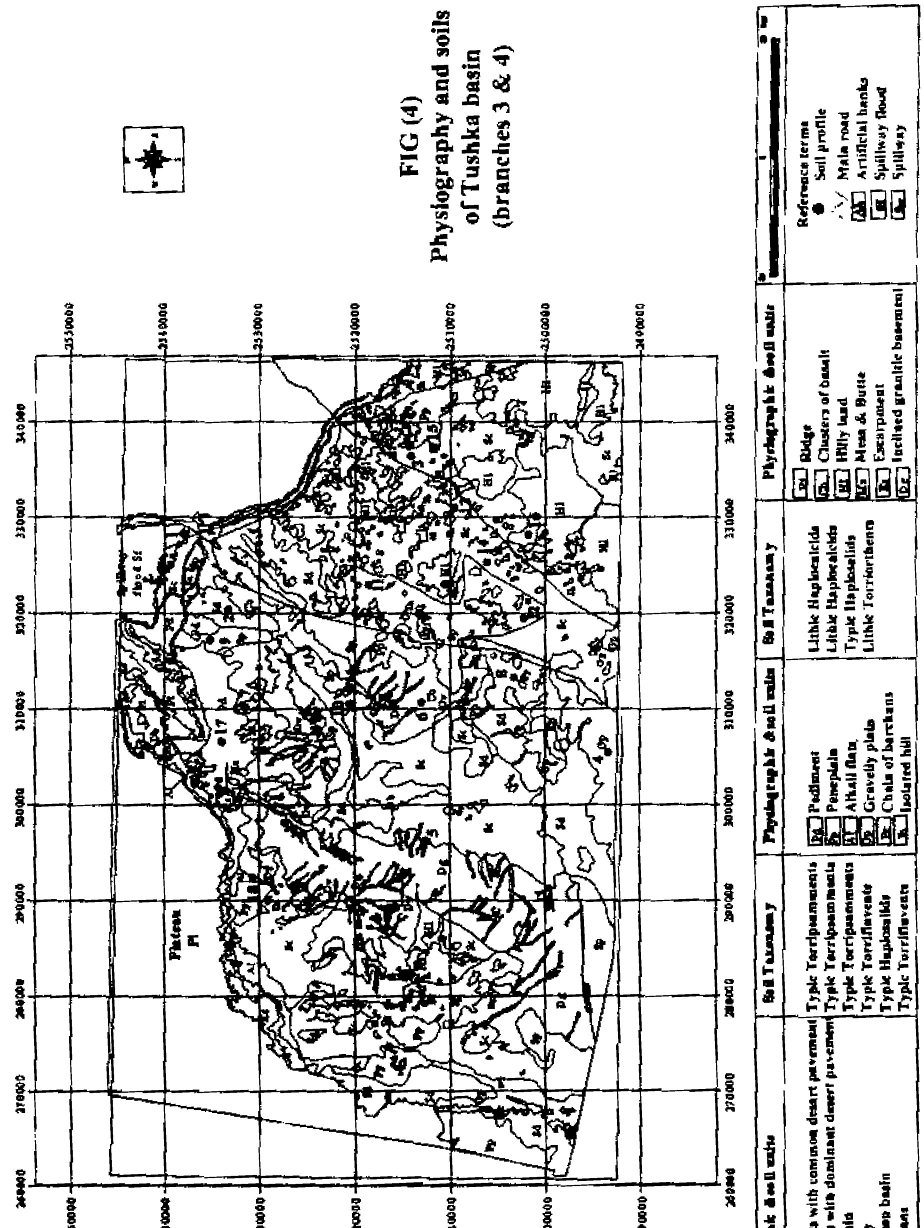


FIG (4)
Physiography and soils of Tushka basin (branches 3 & 4)

$$\text{Productivity Index} = \frac{H}{100} \times \frac{D}{100} \times \frac{P}{100} \times \frac{T}{100} \times \frac{S}{100} \times \frac{O}{100} \times \frac{A}{100} \times \frac{M}{100} \times 100$$

The following table illustrates the average of soil characteristics, their indices and the productivity classes.

Table (5) Average of soil characteristics , score and productivity classes .

Map Units	H	D	P	T	S	O	A	M	Index	Productivity Class
Sf	H5 (100)	D4 (100)	P5 (100)	T4b (50)	S3 (80)	O1 (85)	A1 (90)	M3a (95)	29	III a
Sp	H5 (100)	D4 (100)	P6 (100)	T4b (50)	S2 (70)	O1 (85)	A1 (90)	M2c (100)	27	III a
Dv	H5 (100)	D4 (100)	P5 (100)	T4b (50)	S2 (70)	O1 (85)	A0 (85)	M2c (100)	25	III b
Af	H5 (100)	D4 (100)	P5 (100)	T4a (40)	S3 (80)	O1 (85)	A0 (85)	M2b (95)	22	III b
Sc	H5 (100)	D4 (100)	P5 (100)	T4a (40)	S2 (70)	O1 (85)	A0 (85)	M3a (95)	19	IV a
Sd	H5 (100)	D4 (100)	P5 (100)	T4b (50)	S4 (25)	O1 (85)	A1 (90)	M2b (95)	9	IV b
Db	H5 (100)	D4 (100)	P6 (100)	T7 (100)	S6 (15)	O1 (85)	A1 (90)	M2c (100)	11	IV b
Pp	H5 (100)	D4 (100)	P3 (50)	T4a (40)	S2 (70)	O1 (85)	A0 (85)	M2c (100)	10	IV b
Pd	H5 (100)	D4 (100)	P3 (50)	T4 (50)	S2 (70)	O1 (85)	A0 (85)	M2c (100)	13	IV b
Cb	H5 (100)	D4 (100)	P5 (100)	T4a (40)	S4 (25)	O1 (85)	A0 (85)	M2b (95)	7	V a
Gp	H1 (5)	D4 (100)	P2 (20)	T1a (10)	S6 (5)	O1 (85)	A0 (85)	M1 (85)	0.0003	V b
Al	H5 (100)	D1a (20)	P3 (50)	T5a (50)	S6 (5)	O1 (85)	A2 (95)	M2b (90)	0.009	V b

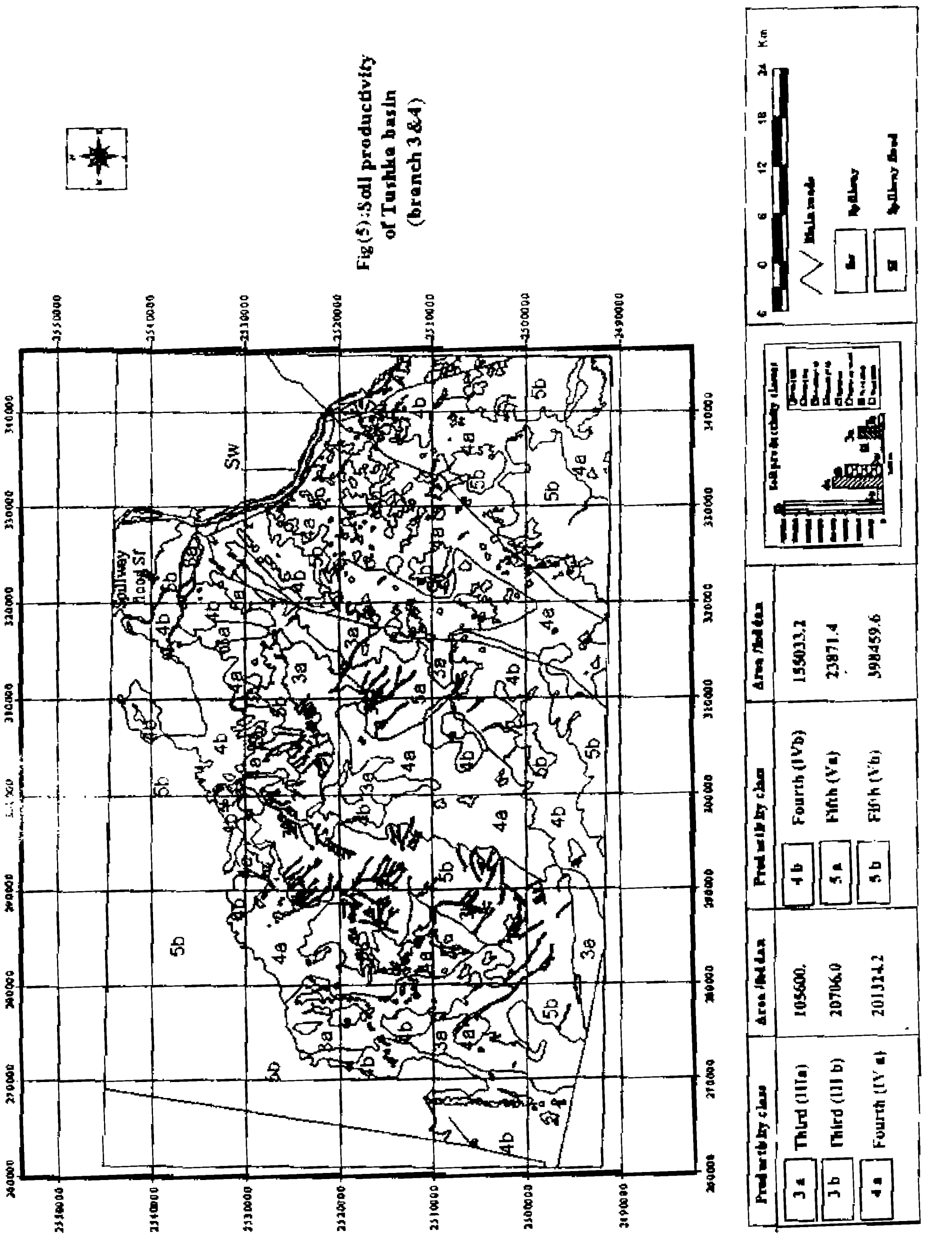
Abbreviations:-H (Moisture) ,D (Drainage),P (Effective depth),T (Texture/Structure),S (Soluble salts concentration),O (Organic matter content),A (Mineral exchange capacity/nature of clay),M (mineral reserve).

Evaluation of the land mapping units

The application of the parametric method for determining productivity classes which has been proposed by Riquier et al.(1970) provides valuable information about the potentialities of each mapping unit for agricultural use. Data in figure (5) show the areas of soil productivity classes .

Table (6) Classification of soil productivity classes .

Mapping unit	Productivity class	Area (Feddan)	%of the total area
Sf & Sp	Third (3A)	105600.6	11.7
Dv & Af	Third (3B)	20706.0	2.3
Sc	Fourth (4A)	201324.2	22.3
Sd ,Dp, Pp & Pd	Fourth (4B)	155033.2	17.1
Cp	Fifth (5a)	23871.4	2.6
Gp &Pl	Fifth (5b)	398459.6	44.0
Total	six classes	904995	100



Fig(5): Soil productivity of Tushka basin (branch 3&4)

The total area that is suitable for agricultural development could be expressed by the Third (a&b) and fourth (a) classes represented by 327630.8 feddans ,otherwise class fourth (b) can be used after getting rid of major constraints in the future.

Suggested land improvements.

The following land improvements are necessary to get rid of or reducing the major constraints to the accepted levels:1-Irrigation by sprinkling is essential and drainage is usually required.2-Deepening of top soil by ridging, deep plowing or breaking up of soil crust.3-Improving of texture/ structure by stone, gravel or rock removal.4-Fertilizers, amendments, liming in adequate quantities are required.5-Desalting irrigation and drainage water in addition to application of gypsum to eliminate sodium salts.6-Enriching and maintenance of organic matter content and application of manure, green manure, mulching.7- Crop rotation is needed.8- Controlling wind erosion by establishing wind breaks.

Water resources & classification.

The study area has more than one water resource (surface or subterranean). It is also confirmed that water resources could be economically used to irrigate about 500000 feddans. Table (7) illustrates irrigation water classification according to Richards (1954) ,where C1-S1 class represents water of spillway flood & canal . Water of this class can be used for irrigation with most crops on most soils and there is no limiting factors. On the other hand water of wells which classified as C3-S1 has no alkalinity hazard but has salinity hazard . This water can not be used on soils with restricted drainage even with adequate drainage, special management for salinity control may be required and salt tolerant plants should be selected. It is advised to mix wells waters with Nile water(1:1 ratio) to get rid of these constraints.

Table (7) Chemical analyses of surface and subterranean water and their classes .

Canal / Well No.	PH	TDS (ppm)	Soluble cations meq/l				Soluble anions meq/l			SAR	Irrigation Water Classification
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Cl^{-}	CO_3^{--}& HCO_3^{-}	SO_4^{--}		
Spillway flood	7.9	230	0.93	0.77	1.02	0.02	0.88	0.73	1.13	1.10	C1-S1
Spillway canal	7.9	220	0.98	0.5	1.12	0.02	0.84	0.70	1.08	1.18	C1-S1
Kurku 3	8.2	1384	4.49	4.30	12.61	0.23	4.20	6.19	11.24	6.01	C3-S1
Kurku 6	8.1	1359	3.99	4.28	12.61	0.23	4.20	5.80	11.11	6.20	C3-S1
Kalabsha 2	7.9	900	4.59	3.04	3.03	0.14	3.47	2 87	4.46	1.55	C3-S1
Kalabsha 4	8.0	910	6.64	2.3	4.57	0.17	3.93	5.29	4.46	2.16	C3-S1
Kalabsha 8	8 1	870	5.49	2.06	5.09	0.14	3.92	4.59	4.27	2.63	C3-S1
Kastal 1	8.2	2030	17.88	6.55	7.47	0.80	6 43	4.16	22 1	2.14	C3-S1
Adindan 1	7.8	1200	10.67	2.82	4.05	0.54	2.49	2.40	13 19	1 56	C3-S1
Adindan 2	7.9	950	7.38	2.62	4.60	0.13	7.1	2.20	5.43	2 05	C3-S1

Recommendations

Sustainable landuse planning of Tushka area will mainly depend on some considerations as follows:

i-Pilot farms or plots size.

For reclamation and cultivation purposes, the land should be subdivided into consolidated plots, each of which shouldn't be less than 10,000 feddans to realize the economic advantages.

ii-Crop structure.

As for crop structure, Tushka area is definitely suited for growing certain crops such as palm trees of different species, medicinal herbs, and winter vegetables, considering the area's mild climate in winter. It is also proposed to cultivate oil and sugar crops such as sugar beet roots and potatoes. Crop structure will be accurately used to serve the various industries and development and export-oriented activities in the area. It is important also to pay attention to various horticultural and none conventional crops, especially high-salinity- resistant and drought resistant ones.

iii-Crop rotation.

Crop rotation, unlike that applied in the old lands, was proposed; i.e. to cultivate only one crop at a time. This would lead to 1- Raise land unit productivity .2 -Make it possible to perform service and harvesting operations promptly ,without waste .3-Ensure that industrial complexes will be operating with high efficiency for processing such crops.

iv-Irrigation system.

Agriculture in Tushka area will depend on an irrigation system based on a number of considerations, main of which are -To control and reduce irrigation water losses along the canal, a dual water level control system and a central automatic control unit has to be established .-(Sub-canals inlets have to be designed so as to allow free water flow to low-lying lands.- Regarding high-lying land, water has to be pumped by lifting stations, which will provide irrigation water as well as other uses .- Water has to be pumped from the sub-canals to the fields through pipes in case of sprinkle and dripping irrigation, and through uncovered tiled canals in case of using advanced surface irrigation methods such as longitudinal lines or oblong fields following necessary soil leveling.

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تحليل مظاهر سطح الأرض كأساس للتعرف على القدرة الانتاجيه لحوض توشكي بمصر العليا

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يعتبر مشروع توشكي واحدا من أهم واكبر المشروعات بمصر؛ وهو يقع بالجانب الغربي لبحيرة ناصر بمصر العليا.ويغطي المشروع مساحة وقدرها١,٥ مليون فدان بها حوالي ٥٠٠ ألف فدان صالحه للاستخدام الزراعي تلك المساحة سوف تروى من مصدرين أساسيين وهما الماء الأرضي والماء السطحي.

والماء الأرضي سوف يكون المصدر الرئيسي للرى اما عن الماء السطحي فسوف يتم استخدامه خلال المواسم العالية لفيضان النيل.

هذا ولقد بذلت في الماضي عده محاولات لاختيار المساحات المناسبة للأغراض الزراعية باستخدام الطرق التقليدية ولكن نظرا للتكلفه العالية والوقت الطويل الذي تستغرقه هذه الطرق خاصه في أراضي هذه المنطقة شديدة الجفاف فلقد تمت الاستعانة باستخدام الطرق الحديثة مثل الاستشعار عن البعد ونظم المعلومات الجغرافية للتخطيط الأمثل لتلك الأراضي ولقد دمجت الصور الفضائية عاليه القدرة التفريقيه من نوعيه TM مع صوره القمر الصناعي الفرنسي Spot فائقة القدرة التفريقيه للحصول على صوره فضائية بها كل الصفات المرغوبة في كلا المرئيتين والهدف من ذلك هو التعرف بدقه على الوحدات الخريطيه المختلفة.

ولقد أمكن التعرف على عدد ١٨ وحده فيزيوجرافيه وهي: أشباه السهول؛ أقدام المنحدرات؛المسطحات القلوية؛ الهضاب الصغيرة والمتقطعة؛ الحواف الجبلية؛ سلاسل البر خانات؛ التلال المنعزلة؛أراضي التلال؛ المراوح الرسوبية؛ السهول المغطاة بالأديم الصحراوي؛السهل الحصوي؛السهل البيدموني؛عناقيد البازلت؛ الاوديه الجافة؛ المنحدرات العميقة ؛ الأحواض التجميعية؛ صخور الأساس المنحدرة واخيرا الهضبة الشمالية.

ولقد تم تقسيم التربة تبعا لإنتاجيتها حيث تم التعرف على الدرجات الإنتاجية للأرض التي تراوحت من الدرجة الثالثة (أ) إلى الخامسة (ب).

اما عن نوعيه المياه المستخدمة سواء كان ماءا ارضيا أو سطحيا فلقد تم تقسيمه طبقا لمعايير معمل الملوحة الأمريكي إلى C1S1 للماء السطحي و C3S1 للماء الأرضي. واخيرا تم وضع عدد من التوصيات لاستخدام الموارد الأرضيه والمائية الاستخدام الأمثل.