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Updating of the Soil Map of the Çukurova University Campus Area by Using Geographic Information System (GIS)

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ABSTRACT

The aim of this study is to update the previous soil map of the Çukurova University campus which was completed in 1974. The widely distributed soil series were selected on previous soil map. Soil series are re-identified and re-sampled in the present study. Physical and chemical analyses were repeated on newly collected soil samples. Satellite image of Quickbird dated 17th of August 2004 were employed for the unsupervised classification. All classes were checked by field truth studies. Previous soil series borders were taken into account during field surveys. The ILSEN software is used to generate Suitability Class of Agricultural Applications (SCAA) and Potential Land Use (PLU). Land Use Capability map (LUC) was made by considering some characteristics which are limiting agricultural managements. Current Land Use map (CLU) is produced via field observations for each land use.

Finally, we determined that there is no significant change between 1974 and updated maps for soil series. But there are some differentiations for soil phases since 1974. All maps of the study are produced at 1:5000 scales.

INTRODUCTION

Soils on the surface of the earth have very complex structure. To determine of the soils is very difficult because of their complication. Soils material which is including productions of the rocks and minerals, inorganic and organic matter with water and air are found in this complex structure (Özbek, 1974). There are many factors for soil formation on the earth; these are different climates, rocks, topography, many living organisms and soils which are different age (Simonson, 1957). When these factors are same in any field, soils have similar properties with each other (Smith, 1963). To know of the soils similar physical, chemical and morphological properties is very important because of suitable using of soils and to raise living standard of the next generation (Özbek, 1974). And effective using of the soil maps is also very significant. Because, use of the soils for agricultural or not agricultural without considering their capability can be confront the human being with uncovering results. We should protect soils against incorrect usage of the people all over the world. Because, soils are valuable for life and it is essential source for life on the earth.

It is possible that soil maps keep their validity for a long time with using new technologies. Hence, satellite images, Geography Information System (GIS) and Geographic Position System (GPS) should be used for updating soil maps. And soil maps which are prepared with field controls should be drew using computer and software.

Aim of this study is updating of the soil map of the University of the Çukurova, which is finished in 1974 by using GIS and QuickBird satellite images. For this aim, satellite image was classified and identified to find for different soil boundaries. Consequently, a new dated soil map of the study area was made and data of the soil series was processed with Ilsen software for land evaluation.

MATERIAL and METHODS

MATERIAL

The study was applied in area of the University of the Çukurova that have 13.305da agricultural field of the total 18.024da areas (Figure 1). QuickBird satellite image, dated from 17 August 2004, and digital topographic maps, at scale 1:25000, was used as base map for field work and laboratory studying. An excavating machine (backhoe) was used in the field work for digging soil profiles. To make soil map bounders certain in the field work was used shovel, auger and standard color chart. Coordinates of the profile sites on satellite image was identified by using GPS. 11 soil profiles was dug, 32 undisturbed and 24 disturbed soil sampling was gathered for chemical and physical analyses. Image process and classification were applied by using Erdas 8.4 and ArcView 3.3 software.

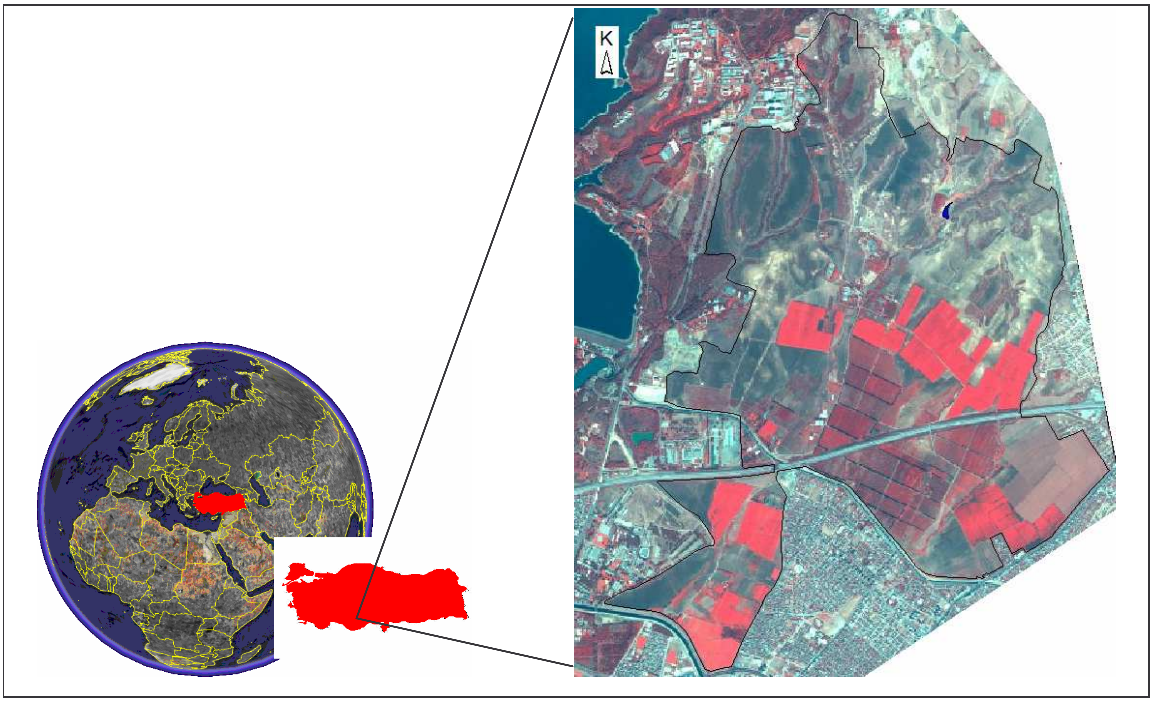

Figure 1. Geographic location of the study area.

METHODS

This study was completed 4 main stages. First stage was including geographic correction of the satellite image and its classification, overlaying border of the study area on the image, digitizing features which are on the topographic map, and identifying soil profiles sites. Second stage was including digging of the soil profiles in the field, its identification and sampling, and physical and chemical analyses of soil samples. Third stage was including digitizing of the detailed soil map (DSM), soil classification and creating of the Land Use Capability (LUC), Potential Land Use (PLU), and Current Land Use (CLU) maps. Fourth stage was including gathering the data and its interpretation, printing of the created maps and final report.

Classification of the satellite image; Image was classified at first 10, 24, 30 classes. All classes were controlled in the field and 24 classes were most suitable for soil diversity of the study area than other classes. Aim of this classification was clustering similar reflectance in the same class. Profile sites were identified on different geographic unite on this satellite image before go to field for first stage.

To excavate of the soil profiles and their sampling; profiles, which were identified on the satellite images, were dug at about 2 meters and 3 or 5 meters length by an excavating machine (backhoe).

Analyses of the laboratory; updated soil analyses were made according to the soil survey report in 1974. Soil samples were sieved <2 mm. Soil texture, acidity (pH), lime (%), Cation exchange capacity (CEC me/100g), changeable cation (K2O kg/da), organic matter (%), bulk density (gr/cm3), electrical conductivity (EC) (mmhos/cm) and phosphor (P2O5 kg/da) were made in this study. Analyze of the soil texture; soil samples were determined content of the sand %, silt % and clay % and texture classes were identified by using texture triangle (Bouyoucos, 1951). Acidity (pH) was determined in the saturation mud by using pH meter (U.S. Salinity Laboratory Staff, 1954). Lime was identified according to Schlichting and Blume (1966). Cation exchange capacity and changeable cations were determined with sodium acetate and acetate extraction methods (U.S. Salinity Laboratory Staff, 1954), respectively. Organic matter was determined by using modified Lichterfelder method (Sclicting and Blume, 1966). Bulk density was identified using undisturbed soil samples according to Yeşilsoy and Güzeliş (1966). Total salinity was defined in saturation mud depending on electrical conductivity (U.S. Salinity Laboratory Staff, 1954). Phosphor analyze was established according to Olsen et al (1957), removing of the color was process according to Kaya (1982), and phosphor was determined as colorimetric according to method of Murpy and Riley (1962).

Soil classification was established according to Soil Taxonomy 2003 (Soil Survey 2003). Shovel, auger, standard color chart and HCl (10%) were used in the field to make definite possible soil borders on the classified satellite image. Possible soil borders were identified according to soil characters which was probe for every 100 or 150 meter distance depending on homogeneity of the study area. Preparing of the soil maps; updated map was established by using QuickBird satellite image and its classified image and topographic map at 1:25.000 scale.

Differentiations of the soil map (1974) were considered when updating of the DSM. The soil map (1974) was overlaid on QuickBird satellite images for effective updating by digitizing. In addition, updating soil map has more comprehensible soil units and soil characteristics than soil map (1974). All maps were established and printed in the Remote Sensing Laboratory of the Soil Science Department of the Çukurova University. LUC, PLU, and CLU maps were generated by using interpretation of the DSM with ILSEN software.

RESULT and DISCUSSION

We determined 10 different soil series on 4 main physiographic units in study area (18.024da). Physiographic units were high marine terrace, shoulder lands, river terrace and alluvial lands (Table 1). There is no significant changing between soil map 1974 and DSM 2008, but there are many changing on phases of soil series. There were two soil series on soil map 1974 which are called Menekşe and İşaret. We did not identify them because there were existed in very little range of the study area according to our soil survey study and satellite images. In addition, we established a new soil series which is called Kabaktepe. It has eroded surface characteristic of the Karaburun series. This characteristic was not identified in soil map 1974. But it was clearly distinguished on satellite image.

Table 1. Soil series and physiographic units of the study area

Soil series	Parent Materials	Physiographic unites
Kızıltapır	Conglomerate	high marine terrace
Baraj	Conglomerate	
Kabaktepe	Travertine	
Balcalı	Travertine	
Karaburun	Travertine	
Konaktaş	Conglomerate	shoulder lands
Hurma	Aged river terrace	river terrace
Mutlu	Aged alluvial deposit	alluvial lands
Arık	Aged alluvial bed deposit	
Menzilat	New alluvial deposit	

We selected some results of the physical, chemical analyses and morphological characteristics of the soil profiles. These are; horizon name, depth of the horizons, pH, salinity, P_2O_5, Cation Exchange Capacity (CEC), lime content, organic matter, texture and classes of the textures. Main descriptive characteristics of the horizons in the soil profiles are cambic, calcic, illuviation of clay and slickenside. These identified properties for each soil series in study area are given following (Table 2).

Identified soils in the study were classified according to Key the Soil Taxonomy, 2003. Inceptisols has more soil series than others, four soil series were classified as Inceptisols. One soil series was classified as Entisols. Orders, suborders, great groups and subgroups are given in Table 3.

Table 2. Soil properties for each soil series in study area.

Soil Series	horizon	Depth (cm)	pH	P_2O_5	CEC	$CaCO_3$ (%)	Org. mat	Tex. Dis. (%)			Tex. Clas
								S	Si	C	
Karaburun	Ap	0-20	7,32	6,02	33,06	18,1	2,2	26	24	50	C
	A2	20-35	7,34	2,75	27,30	17,7	2,0	28	20	52	C
	Bw	35-66	7,28	1,27	17,17	14,8	1,1	17	20	63	C
	BCk	66-109	7,34	2,16	11,22	47,7	0,7	24	31	45	C
	Ck	109-120	7,24	0,50	8,34	66,2	0,4	19	40	41	SiC
Kabaktepe	Ap	0-19	7,19	22,28	33,06	52,8	1,1	29	44	27	L
	A2	19-36	7,30	2,31	27,30	55,7	0,9	30	44	26	L
	2Ck	36-90	7,34	0,40	17,17	63,1	0,3	22	52	26	SiL
Balcalı	Ap	0-10	7,27	21,71	16,68	8,8	2,3	37	23	40	CL
	A2	10-24	7,31	2,93	14,59	10,8	1,9	34	21	45	C
	Bt1	24-44	7,24	2,82	15,78	11,5	1,5	29	23	48	C
	Bt2	44-64	7,31	1,18	33,36	26,8	1,0	29	20	51	C
	BC	64-79	7,13	1,05	15,78	19,7	0,8	31	18	51	C
	Ck	79-118	7,44	0,19	9,23	58,5	0,3	35	41	24	L
	Ap	0-13	6,80	9,92	17,67	0,8	2,5	18	22	60	C
	Bt1(BA)	13-28	6,68	1,87	20,65	0	1,6	25	17	58	C

Kızıltapır	Bt2	28-43	6,60	1,65	18,37	0	1,7	18	25	57	C
	B/Ck	43-64	7,35	0,89	29,19	45,4	1,0	42	26	32	CL
	Ck	64-80	-	-	-	-	-	-	-	-	-
Baraj	A1	0-11	6,93	16,65	18,07	25,9	5,8	39	30	31	CL
	A2	11-33	7,30	2,74	14,89	27,4	2,8	37	29	34	CL
	Ck	33-70	7,19	0,66	20,15	73,9	1,0	21	41	38	CL
	Cr	70+	-	-	-	-	-	-	-	-	-
Konaktaş	A	0-17	6,97	3,42	16,18	6,0	4,4	60	13	27	SCL
	Bw	17-35	7,40	1,40	11,52	11,5	1,8	51	16	33	SCL
	Ck	35-	-	-	-	-	-	-	-	-	-
Hurma	Ap	0-14	7,04	2,27	23,23	6,2	2,1	23	21	56	C
	A2	14-33	7,16	0,91	19,06	9,2	1,2	23	20	57	C
	A3ss	33-87	7,47	0,57	38,91	9,5	1,1	19	22	59	C
	A4ss	87-111	7,46	1,40	16,08	10,6	0,9	18	19	63	C
	AC	111-150	1,40	0,44	17,87	11,4	0,9	15	20	65	C
Menzilat	Ap	0-31	7,57	4,99	20,50	31,5	1,51	36	27	37	CL
	CA	31-59	7,95	1,99	17,87	47,4	0,49	36	30	34	CL
	C1	59-94	7,80	1,49	24,90	48,8	0,51	14	41	45	SiC
	C2	94-125	7,81	1,25	18,40	55,0	0,52	11	44	45	SiC
	C3	125-150	7,90	2,16	19,99	47,5	0,47	18	40	42	C
Mutlu	Ap	0-20	7,29	3,73	14,69	12,2	1,5	29	27	44	C
	A2	20-48	7,29	0,84	17,37	13,4	1,0	24	19	57	C
	ACss	48-82	7,19	0,69	17,57	8,0	0,9	18	19	63	C
	Css	82-133	7,37	0,65	17,67	12,2	0,9	18	19	63	C

	Cr	133-150	-	-	-	-	-	-	-	-	-
Arık	A	0-25	7,63	7,11	46,83	27,2	1,17	17	28	55	C
	A2ss	25-45	7,80	1,92	37,51	27,0	0,62	15	27	58	C
	A3ss	45-84	7,81	1,28	38,14	26,3	0,57	14	27	59	C
	ACss	84-110	7,89	1,17	39,84	25,6	0,55	15	26	59	C
	Css	110-150	7,96	1,23	40,77	25,0	0,44	14	25	61	C

Table 3. Soil Classification of the soil series of the study area.

	Key the Soil Taxonomy, 2003			
	Sub Group	Great Group	Sub Orders	Orders
Kabaktepe	Lithic Calcixerepts	Calcixerepts	Xerepts	Inceptisols
Konaktaş				
Baraj	Typic Calcixerepts			
Karaburun				
Mutlu	Chromic Haploxererts	Haploxererts	Xererts	Vertisols
Hurma	Typic Haploxererts			
Arık				
Kızıltapır	Calcic Rhodoxeralfs	Rhodoxeralfs	Xeralfs	Alfisols
Balcalı				
Menzilat	Typic Xerofluvents	Xerofluvents	Fluvents	Entisols

There are four utilization groups for PLU; these are horticulture, field crops, vegetables and nonagricultural areas. Contents of each utilization group were given in Table 4. V4, H2, F9 and N8 are including most suitable plants for their utilization groups. V4, H2, F9 and N8 are suitable of 53%, 35%, 28% and 25%, respectively (Figure 2, 3, 4, 5). Utilization groups of PLU for horticulture, filed crops, vegetables and nonagricultural are given in Table 4.

Table 4. Utilization Groups of PLU

1	**Utilization Group of Horticulture** (Citrus tree, Vineyard, Peach tree, Olive tree, Almond tree, Fig tree)
H0	:no suitable
H1	:Olive tree, Fig tree
H2	:Vineyard, Olive tree, Almond tree, Fig tree
H3	:Citrus tree, Vineyard, Peach tree, Olive tree, Almond tree, Fig tree
2	**Utilization Group of Field Crops** (Wheat-barley plant, Maize plant, Clover, Chickpea plant, Potato plant)
F0	:no suitable
F1	:Chickpea plant
F2	:Chickpea plant, Potato plant
F3	:Wheat-barley plant
F4	:Wheat-barley plant, Chickpea plant
F5	:Wheat-barley plant, Maize plant
F6	:Wheat-barley plant, Maize plant, Chickpea plant
F7	:Wheat-barley plant, Maize plant, Chickpea plant, Potato plant
F8	:Wheat-barley plant, Maize plant, Clover
F9	:Wheat-barley plant, Maize plant, Clover, Chickpea plant, Potato plant
3	**Utilization Group of Vegetables** (Tomato plant, Watermelon - melon plants, Strawberry plant)
V0	:no suitable
V1	: Watermelon - melon plants
V2	:Tomato plant
V3	:Tomato plant, Watermelon - melon plants
V4	:Tomato plant, Watermelon - melon plants, Strawberry plant
4	**Utilization Group of Nonagricultural** (Greenhouse, Grassland, afforest ration (for erosion control), afforest ration (for timber), Natural land, Cow house, Buildings, Recreation land)
N0	:Natural land, Recreation land
N1	:Natural land, Cow house, Buildings, Recreation land
N2	:Grassland, Natural land, Recreation land
N3	:Grassland, Natural land, Cow house, Buildings, Recreation land
N4	:Grassland, afforest ration (for timber)
N5	:Grassland, afforest ration (for timber), Natural land
N6	:Grassland, afforest ration (for erosion control), afforest ration (for timber)
N7	:Grassland, afforest ration (for erosion control), afforest ration (for timber), : Natural land
N8	:Greenhouse, Grassland, afforest ration (for timber)
N9	:Greenhouse Grassland, afforest ration (for timber), : Natural land

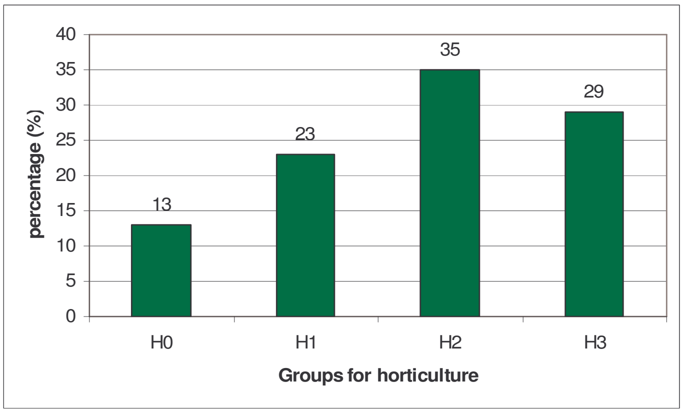

Figure 2. Percentage of the PLU of groups for horticulture in whole study area.

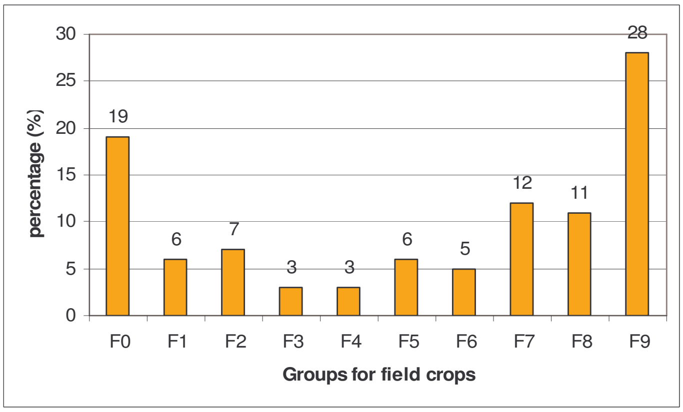

Figure 3. Percentage of the PLU groups for field crops in whole study area.

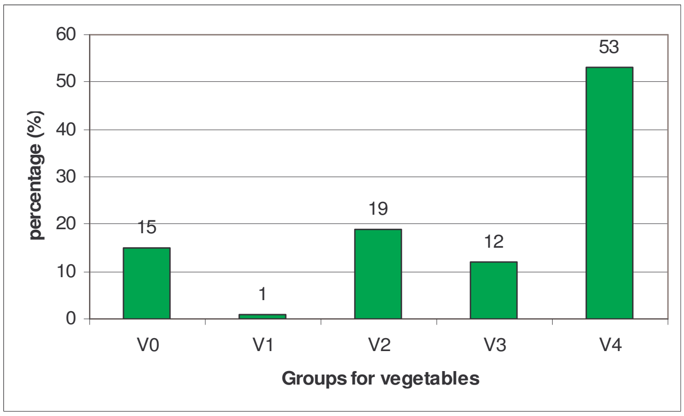

Figure 4. Percentage of the PLU groups for vegetables in whole study area.

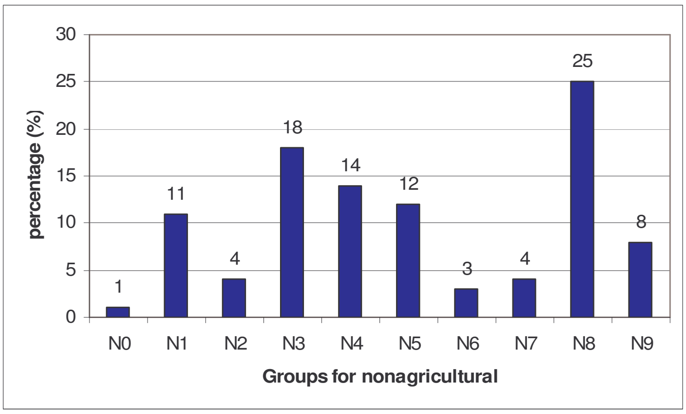

Figure 5. Percentage of the PLU groups for nonagricultural in whole study area.

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