UPDATING SOIL CHARACTERISTICS OF ÇUKUROVA REGION (SOUTHERN TURKEY) USING GEOGRAPHICAL INFORMATION SYSTEMS AND ILSEN SOFTWARE

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ABSTRACT

The soil map of Çukurova University’s (Southern Turkey) campus Adana (1802 ha) was prepared by conventional air-photo interpretation in 1974, and is updated by employing geographical information system and remote sensing techniques. Soils of the campus are developed on alluvial deposits (35%), conglomerates (33%), calcrite (25%) and old river terraces (7%). Soils having 90-120 cm depth cover 26% of the total area whereas shallow soils (10-30cm) occupy 22%. The large area (86%) of region overlay on flat (0-2%) or gently sloping lands (2-6%), whereas strongly sloping lands (12-24%) cover only 14%. Four diagnostic horizons were determined as Bw; Ck; Bw-Ck and Bt-Ck with 4%, 21%, 12% and 16% distribution. Land Capability Classification (LCC) I, II and III cover 87.3% of the total geographical area whereas soils of VI and VII class only 12.7%. Soils are classified into Entisol, Inceptisol, Vertisol and Alfisol orders with 16%, 40%, 26% and 18% distribution.

Keywords: GIS, Soil map, Remote sensing, Land capability classes, Land suitability classes, Land use, Taxonomy,

INTRODUCTION

The use of state of the art technologies in soil surveys offer quick access to accurate information particularly digital soil data processed in Geographic Information Systems (GIS) increased the use of soil survey outcomes (Bicki, 1991; Bonta, 1998). Several institutions are supporting soil information based on digital data (Lee et al., 1999) because preparation is cost effective (Rogowski and Wolf, 1994; Wagenet et al., 1991; Wosten et al., 1985). Soils may vary within small distances, and personal mappings when coupled with minor differences in soil development, would yield different maps within same region (Eckenrode and Ciolkosz, 1999).

Farmers are anxious to know soil physical characteristics since tillage, compaction, root development, exchange of gases and hydraulic properties are the functions of soil resistance (Bauer et al., 1972), and soils are managed accordingly.

Detailed information on soils is crucial for land resource management and environmental modeling (Gobin et al., 2000). However, soil data obtained from conventional soil survey maps covers relatively small areas (Ahn et al., 1999). The handling cost of printed maps is expensive (Mc Kenzie et al., 2000) and updating printed maps is not possible. Modeling tools like GIS provided more and accurate data than conventional soil maps (Cook et al., 1996; Gessler et al., 1995).

The detailed soil map prepared by conventional techniques for Çukurova University
campus in 1974 is updated through GIS and remote sensing techniques for developing a model for updating similar maps.

**MATERIAL AND METHODS**

The study is undertaken on North of Adana, Turkey (1802 ha) Çukurova University Campus Research Farm located between 37°03′47″N and 37°00′15″N and 35°20′12″E and 35°24′47″E at an elevation ranging from 29 m to 150 m above mean sea level (Figure 1).

Topographic maps at 1:25000 scale and Quickbird image of 17th of August 2004 were used for field surveys. Eleven pits (profiles) were studied and horizon-wise soil samples (32) were collected for laboratory Characterisation Soil map and satellite images were evaluated by ArcView 9.3 and Erdas Imagine 9.3.2 software.

Geo-reprocessing and classification of Quickbird image were undertaken through topographic map coordinates using ERDAS IMAGINE software (Ver. 9.3.2). Land use and soil types were determined by ground truth and unsupervised classification of satellite image. For unsupervised classification, 6, 12, 24, 30 and 36 segments were set. However, data loss was observed for 6 and 12 segmented unsupervised classes during ground truth studies. Two or more soil types or land uses with different properties were grouped into same type or class at 6 and/or 12 segmented classification. But, when 30 and 36 segmented classes were used, soils and land use types with similar properties were grouped into different types. Field studies revealed that for Quickbird images, 24 segmented classifications is optimal for soil and land use studies.

Soil boundaries of supervised classification image were checked and confirmed. First, kind of the soils were identified, sampled and recorded. Second, satellite images were interpreted to select all different soil boundaries. Third, soil boundaries were controlled in the field by using auger hole (it is a way to see vertical

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**Fig. 1:** Location of the study area.
changing of the profiles), soil color chart and effervescence with 10% HCl. Soils were compared with identified profiles and were drawn accurate boundaries on the images in the field. Finally, accurate soil boundaries were digitized from image sheets to computer by using ArcView 9.3.

Soils are classified according to Soil Taxonomy (Soil Survey Staff, 2003). Soil parameters that delineate series and phases such as surface soil texture, slope, soil depth, carbonate content and surface color were controlled during field surveys. Detailed soil map was produced following ground truth. All soil data is stored in ArcView 9.3 and Ilsen softwares. Accordingly detailed soil map and other thematic maps (land capability, land suitability classes) were generated.

Ilsen is widely used software developed for IBM compatible computers working under DOS operating system by Microsoft COBOL complier (Version 4.5).

RESULTS AND DISCUSSION

Alluvial deposits are the major geological of formation 35% cover, followed by conglomerates (33%), calcretes (25%) and old river terraces (7%). Shallow soil depth was not considered as limiting factor for cultivation in the study site since very shallow (0-10cm) and shallow (10-30cm) soils only cover 22% of the total area. The average soil depth was 90-120cm with 26% coverage. The slope classes were A; 0–2%, B; 2–6%, C; 6–12% and D; 12–24% with 50%, 36%, 13% and 1% of distributions (Figure 2) and sloping is not a limiting factor for agricultural practices since major slopes are varied from 0-6% with 86% distribution.

During field studies, 5 different designation horizon (DH) were defined. Some soils did not have

![Fig. 2: The distribution of slope classes in the study area.](image1)

![Fig. 3: The distribution of soil orders in the study area.](image2)

![Fig. 4: Distribution of Descriptive Horizons in the study area.](image3)

![Fig. 5: The adoption and accuracy of 1974 (B) and updated map (A) to satellite image (1, 2, 3 and 4 refers to the same locations both A and B).](image4)
any DH and they cover 15% of the area. Soils with calcic horizon (Ck) covered 21%, soils with illuvial/argillic (Bt) and calcic horizons covered 16% of the area. Cambic and calcic horizons found together in 12% of the soils, soils with cambic horizon covered 4% of the area. A total of 11 soil series were defined and classified into 4 orders namely Entisols, Inceptisols, Vertisols and Alfisols (Figure 3).

There were 4 descriptive horizons namely Bw; Ck; Bw-Ck; and Bt-Ck. Soils with these descriptive horizons occupy 4%, 21%, 12% and 16% respectively (Figure 4). However, soils without designation horizons covered 15% of the area.

LCC I, II and III covered 87.3% and VI and VII 12.7% of the total area, respectively. The soils were grouped in LCC land classes II occupy 49.6 % area. Prime lands in LCC I soils cover only 0.4%. LUC 1 and 2 classes followed the distribution pattern of LCC I and II. In old soil (1974) and updated maps are presented in Fig 2 (A&B). Soil boundaries delineated during field survey are superposed over satellite image an GIS platform which helped in delineating the temporal changes that occurred. The soil boundaries were not delineated in 1974 map but are introduced in updated map (Fig 5).

It is concluded that ILSEN Software when coupled in combination both remote sensing and GIS, in general produce promising results for better soil maps than conventional soil maps.

REFERENCES