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The Relationships Between Land Use Types And Moisture Contents At The Surface Soil In The Çankı rı -Eldivan Region

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ABSTRACT

The objective of this study was to investigate the effects of different land uses (agriculture-forest- grassland) and aspect on hydrophysical soil properties. In order to determine those effects, some hydrophysical and chemical analysis were done on 79 soil samples from 21 soil profiles at two aspects covered by natural forest (NF), plantation (afforested area-AF), grazing land (GL) and agricultural land (AL). Results showed that hydraulic conductivities significantly changed with land use type, while hydraulic conductivity and field capacity changed with aspect.

Key words: Land use type, soil, hydrophysical soil properties, Çankı rı - Eldivan

1. INTRODUCTION

Soil is a natural resource which can only be sustainable if managed properly. Hence, the main purpose of any land use should be conservation and preservation of the soil to guarantee and sustain high production.

Water scarcity and low precipitation are major constraints at the research area, Çankı rı - Eldivan, which is located in the north of the Central Anatolia. Data on hydrophysical properties of the regional soils may help and guide planners and other technical staff in determination of proper land use management systems. This could prevent improper land use practices and might contribute on rural development and sustainable use of natural resources.

The objective of this study was to determine the relationships between retention and movement of water in the soil, and land use and aspect. Soil moisture, being a basic component of hydrological cycle was monitored as an important hydrometeorological parameter. Aspect was also assessed because of its significant effects on rainfall and evaporation regimes.

2. MATERIAL AND METHOD

2.1. Material

Research area is ca. 100 ha and is situated at the southeast of Eldivan, a town which is located at the Central Kı zı lı rmak Region of the Central Anatolia. Its coordinates are 40° 34' 41" - 40

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20' 38" N latitudes and 33° 36' 00" – 33° 25' 10" E longitudes. The study area covers the lands of Eldivan district, and Gölez and Gölezkayı villages.

The climatic type of the region was determined by using the data from the Eldivan Climate Station (Anonymous, 2001) according to the Thornthwaite method (Göl, 2002). Climate type at the research area was "C_1 B'_1 s b'_2" which means "arid-subhumid, mesothermal, moderately excessive water during winters, close marine" climate type.

Research area is included in the Iran-Turan flora zone, which is one of the three main zones in Turkey. It is at A4 square according to the Davis's squaring system (Anşin, 1983).

Research area was formed of Tertiary Oligo-miocene gypsum series. That formation starts with thick and red bottom conglomeras followed by light color clay and marl, stratified with gypsum. Top strata of the gypsum series may include Miocene at many locations. This sequence implies marine regression and replacement of desert climate (Ketin, 1962).

There was concentrated pressure on regional resources by the poor rural inhabitants. Cereal production is common practice due to water scarcity. Vegetable and fruit growing was confined to small home gardens. Large number of local people has been migrating from villages to urban areas. Both agriculture and animal husbandry are at minimal levels because of the low population of youngsters.

2.2. Method

Soil profile locations were determined by inspecting present land uses, aspect, landscape and geological features.

As there were no NFs at the southern aspect, total number of soil profiles was 21. The profiles were dug to parent rock or to 1.20 cm where parent rock was deeper. A few exceptions were 140-1.50 cm deep. Two core samples were taken from 0-15 cm depth with 400 cm^3 labeled cylinders. Some 1.5-2 kg disturbed samples were collected within the horizon basis.

Disturbed soil samples were air-dried, crushed and sieved 2 mm for preparing to analyze.

Texture (Bouyoucos, 1951) with hydrometer method and texture triangle (Soil Survey, 1993), hydraulic conductivity (Özyuvacı, 1976), saturation percentage (Richards, 1954), maximum water holding capacity (Okatan, 1986), field capacity, permanent wilting point and available water content (Cassel & Nielsen, 1986), organic matter with modified Walkley-Black method (Jackson, 1967) were determined.

The effects of land use type and aspect on some soil properties were determined with factorial variance analysis technique with using Duncan multiple comparison method for grouping significantly different parameters. For the purpose, 0-15 cm surface samples were employed in the statistical analysis.

3. RESULTS

The highest hydraulic conductivities at the northern slope were at the NF soils with an average of 27.58 $cm.h^{-1}$, whereas the lowest average was 5.08 $cm.h^{-1}$ at the cultivated land.

Those values were 22.06 $cm.h^{-1}$, and 2.08 $cm.h^{-1}$ at the northern slope, at the grazing land and field, respectively.

Variance analysis indicated that hydraulic conductivities were not significantly different at northern and southern aspects. Duncan analysis revealed that the difference (P<0.05) was due to the variance between the agricultural and NF lands. Hydraulic conductivities were higher at the forest soils (Table 1).

Table 1. The results of Duncan test to compare the effect of land use on hydraulic conductivity

Land use	N	$\bar{X} \pm S_{\bar{X}}$
Agriculture	6	3.58 ± 1.10 b
Grazing land	6	16.53 ± 8.51 ab
Afforested area	6	16.59 ± 3.13 ab
Natural forest	3	27.58 ± 4.05 a

The highest field capacity (FC), permanent wilting point (PWP), and available moisture (AMC) content values at the northern slopes were at the NF soils, likely due to high organic matter and clay contents. Grazing land soils had the highest moisture contents at FC at the southern slope.

Land use did not influence moisture contents at FC in the surface soils while significant differences (P<0.05) were determined between the aspects.

The highest moisture content PWP was measured with the NF soil at northern slope where the highest and the lowest contents were at the grazing land and at the agricultural land, respectively at the southern side. One may take that comment arbitrary as statistical analysis did not support the explanation. Organic matter content, structure and root development, all of which were closely dependent on land use, might cause minor changes in PWP.

Available moisture contents were similar at all land uses and aspects, values changing 14.46% at AL, 14.04% at NF at the northern slope and 13.78% at AL and 13.05% at AF at the southern slope, respectively. The highest AMC was measured at the southern GL while the lowest was at the northern GL. There were no significant differences between the AMCs of North and South soils. AMCs of the AF and AL at northern slope were slightly lower than the southern ones.

4. DISCUSSION

Clear compaction indications under the A_p horizon of the AL soils indicated that this compacted layer adversely affected hydraulic conductivity. Naturally, the most permeable layer among all was the surface horizon of NF in debt to its high organic remnant content, developed structure and root residues. Another highly permeable horizon was southern pasture where grazing has been forbidden since 1960s resulting in increase in organic matter content and protected from any footsteps.

Variance analysis and Duncan tests showed significant differences in hydraulic conductivities between land uses. It was determined that hydraulic conductivity was higher at the NF than at the AL. That difference was not the case for aspect variability. However, northern slope soils had slightly less hydraulic conductivity when compared to the southern slope soils. Note the consumption of organic matter and compaction effects of grazing at the former, while relatively virgin southern slope soils. Less clay content likely because of the higher historical erosion might be another factor at the northern aspect.

Hydraulic conductivities at the southern slope surface soils were higher at the southern-GL soils. It was probably frequent tillage operations which deteriorated the structure causing reduced hydraulic conductivity. Fringy root system of grasses might increase hydraulic conductivity at the GLs. Protection from footsteps/compaction at the southern slope may contribute to that increase.

Statistical analysis indicated that land use did not affect FC, whereas significant differences ($P<0.05$) between the aspects were noted. Soil moisture contents at FC and PWP were higher where clay and organic matter contents were high. The NF soils gave the highest FC and PWP moisture contents at the northern slope which was attributed to high moisture retention capacity of organic matter. At the southern slope, regular support of annual plant residues may be the prevailing factor in the measured highest moisture contents at FC and PWP.

Variance analysis did not verify any differences between PWPs of land uses. Vague ranges in moisture contents may likely come from organic matter content, structural stability, root development etc. changing soil properties.

All soils had similar AMCs at both aspects. That similarity was more pronounced between AL and NF at the northern slope and, between AL and AF soils at the southern slope.

5. LITERATURE CITED

Anonymous, 2001. Eldivan meteoroloji istasyonu iklim verileri. Meteoroloji Genel Müdürlüğü Kayıtları, Ankara, Turkey (In Turkish).
Anşin, R. 1983. Türkiye'nin flora bölgeleri ve bu bölgelerde yayılan asal vejetasyon tipleri. Karadeniz Teknik Üniversitesi, Orman Fak. Dergisi Yıl 1983, Cilt: 6, Sayı: 2, Trabzon, Turkey (In Turkish).
Bouyoucos, G.J. 1951. A Recalibration of The Hydrometer For Making Mecanical Analysis of Soil. Agro. J. No: 43; 434-438.
Cassel, D.K., Nielsen, D.R. 1986. Mehods of Soil Analysis, Part 1, Physical and Mineralogical Methods-Agronomy Monograph no.9 (2nd edition) American Society of Agronomy-Soil Science Society of America, Madison, USA
Göl, C. 2002. Çankırı-Eldivan Yöresinde Arazi Kullanım Türleri ile Bazı Toprak Özellikleri Arasındaki İlişkiler. A.Ü. Fen Bilimleri Enstitüsü, Doktora Tezi (yayınlanmamış), Ankara, Turkey (In Turkish).
Jackson, M.L. 1967. Soil Chemical Analysis. Prince Hall Inc. Englewood Cliffs, N.J., USA.
Ketin, İ. 1962. 1:500 000 Ölçekli Türkiye Jeoloji Haritası. Sinop. MTA Yayınları. Ankara, Turkey (In Turkish).
Özyuvacı, N. 1976. Arnavutköy Deresi Yağış Havzasında Hidrolojik Durumu Etkileyen Bazı Bitki-Toprak Su İlişkileri. İ.Ü. Orman Fak. F. Yayın No: 221 Ü.Yayın No: 2082, İstanbul, Turkey (In Turkish).
Richards, L.A. 1954. Diagnosis and Improvement of Saline and Alkali Soils (moisture retantion curve). Dept. of Agri. Handbook 60. USA.
Soil Survey Staff. 1993. Soil Survey Manual. USDA. Handbook No: 18. Washington D.C