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SOIL ORGANIC CARBON STOCKS OF EAST ANATOLIA REGION IN TURKEY

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Abstract. *Soils are an important constituent of global carbon cycle, can be either net sources or net sinks of atmospheric carbon dioxide (CO_2). In this study, soil organic carbon (SOC) stocks of common Great Soil Groups (GSG) in East Anatolia Region (EAR) were determined. Carbon stocks are calculated between from 0-100 cm soil depth at GSG. According to our study, SOC amounts of Great Soil Groups are low to high determined as Grey-Brown 4.36, Brown 4.36, Non-Calcareous Brown 6.54, Colluvial 7.55, Alluvial 7.80, Alluvial Coast 8.00, Hydromorphic 12.00 and Chestnut soil 14.90 kg C m^{-2}, respectively. Soil organic carbon amounts were higher in Chestnut and in Hydromorphic soils. Chestnut soils have the most organic carbon (OC) amount and organic carbon stocks while SOC was lower in Grey-Brown and Brown GSG. The total SOC is 131.92 Tg C of which Chestnut is 73.78 Tg C. Generally, it is seen that SOC is low in the area where intense agriculture technique is used and it is high in forest area which from high area.*

Key words: *organic carbon amounts, organic carbon stocks, intense agriculture technique, Van GSG, high area, Turkey*

Abbreviations: C, carbon; SOC, soil organic carbon; GSG, great soil groups; OC, organic carbon; CO_2, carbon dioxide; IPCC, Intergovernmental panel on climate change; EAR, East Anatolia Region; MWEG, member of the ecosystem working groups; SIC, soil inorganic carbon; SAR, Southeast Anatolia Region.

INTRODUCTION

The soil is a key constituent of global carbon cycle. Soil organic carbon stocks are biggest ecosystem carbon repository in the world. It is necessary for enhancing quality of soil, sustaining and improving food production, saving clean water, and reducing the CO_2 which has been rising in the atmosphere (Eswaran & Vander Berge 1992; IPCC 2000; Pan et al. 2002).

According to, scientists from all over the world have begun many studies on SOC stock (Schlesinger 1990; Bolin & Sukumar, 2000).

Many factors affect the biogeochemical cycle of SOC and therefore also affect SOC stocks and distribution. One of the most important factors is land-use change. While converting natural forest areas and meadows to farming areas affects SOC stocks in different ways in different ecosystems and regions (Solomon et al. 2000; Rodriguez-Murillo 2001; Powers 2004; Yimer et al. 2007), cultivation and other deformations cause approximately 40 Pg of C loss. Nearly 1.6 Pg C y^{-1} were released in the 1990s (Smith 2008). Developing non-cultivated agriculture techniques can decreases SOC pool decrease which emerged as a result of natural and forest areas decrease (Puget & Lal 2005; Grandy & Robertson 2007).

The world soils are vast reservoir of carbon with estimate between from 1150 to 2200 Pg in a meter of soil profile (Post et al. 1982; Eswaran et al. 1993; Batjes 1996). Rather, the IPCC estimates 1750±250 Pg C, whereof 835 Pg is soil inorganic carbon (IPCC 2001). According to estimates of the other scientists, the total SOC content of all soils in the 0-100 cm (upper 0-1 m) layer is estimate ranging 1500 to 2000 Pg C (Eswaran et al. 1993; Batjes 1996).

Organic carbon stock is estimated 7.72 Pg (Amthor et al. 1998) and 6.8 Pg (Sakin 2010) in Turkey soils. However, no valid information on soil inorganic carbon stocks of Southeast Anatolia Region has been documented. The objectives of this paper are to estimate soil organic carbon stock region of East Anatolia.

MATERIALS AND METHODS

Material

The research area extends between 37º 55' and 39º 24' N latitudes, 42º 05' and 44º 22' E longitudes and covers approximately 21 000 km^2 and 1 934 km^2 of it consists of Van lake. Van region is contained a variety of natural regions. Study area and Van Great Soil Groups are showed in figure 1. Great Soil Groups are, Alluvial, Alluvial Coast, Grey-Brown, Hydromorphic, Brown, Brown Forest, Maroon, Non-Calcareous Brown, Non- Calcareous Brown Forest, Colluvial and Regosols (Van Basin Soils, 1971), Respectively. The mean annual temperature is 8.3 and 8.8 ºC in research area, with total temperature is 22 ºC in Van, and 21.9 ºC in Ercis and 21.2 ºC in Tatvan. The annual precipitation amount (31 years) is 578.6 mm in Van, 771.9 mm in Tatvan and 490.5 mm in Ercis (Ergene 1972).

Methods

Some data of the at this study was taken from Ph. D thesis of Aksu in 1977. One profile of each GSG was examined. Samples were taken from each horizon and 41

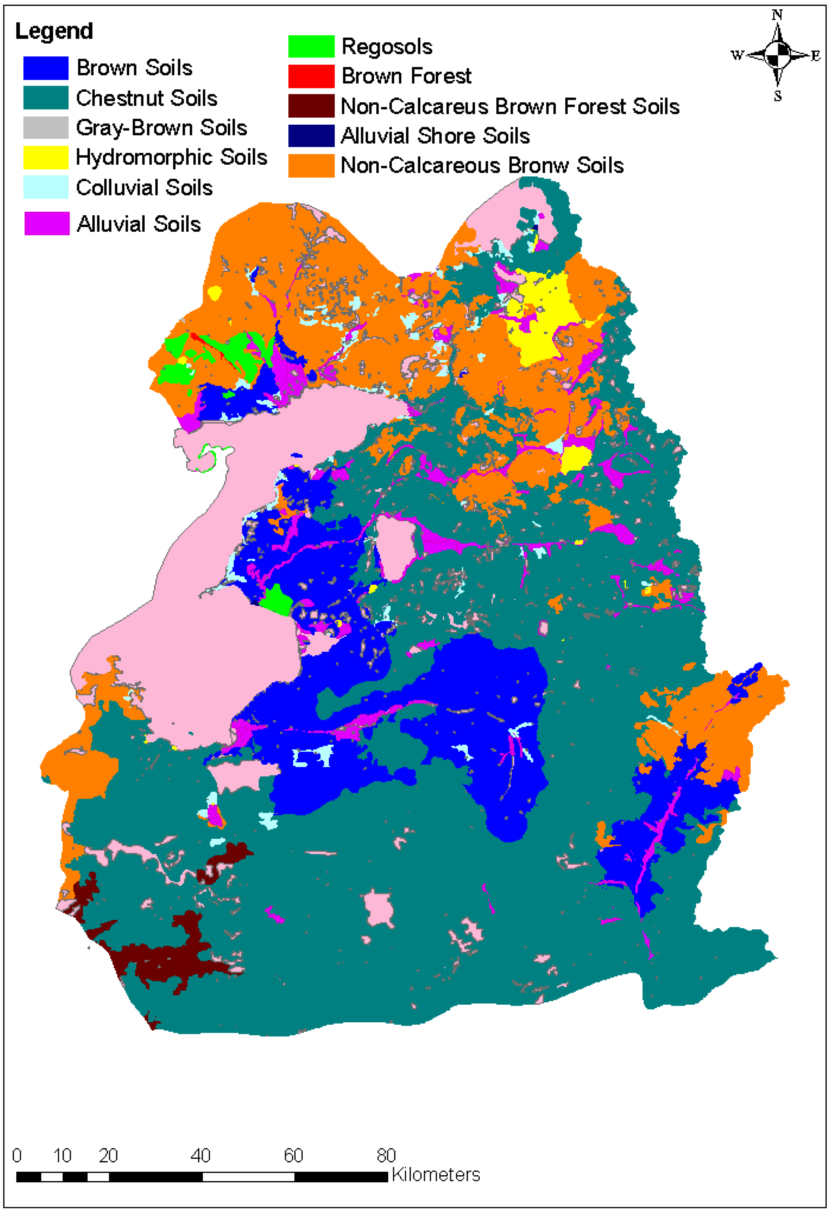

Figure 1. Great Soil Groups and study area

samples. Mean soil organic carbon amount (kg C m^{-2}) was computed according to each horizon taken from 11 GSG and between 0-100 cm soil depth. Soil organic carbon were calculated (Batjes 1996) from soil organic matter the determined by Aksu (1977) and a conversion coefficient of 0.58 was used in the present study (Nelson & Sommers 1982; Fang et al. 1996; Post et al. 1982; Scott et al. 1999; Li et al. 2001). Bulk density (BD) of the soil was measured as described in Sakin (2010b).

SOC= (Di×Dbi×%OCi/1.724)/10 (1)

Where SOC is the soil organic carbon stock (kg C m^{-2}), Dbi is the bulk density (Mg m^{-3}) of layer i, OCi is the proportion of organic carbon (%) in layer i, Di is the thickness of the layer (cm).

RESULTS AND DISCUSSION

Total SOC stock was estimated as 131.92 Tg (1 Tg=10^{12}g) or 0.132 Pg (1 Pg=10^{15}g) (Table 1). The Chesnut GSG had 73.87 Tg, which was about 56% of total carbon. Non-Calcareous, which occupy the second largest area (21.10%), contained 25.95 Tg SOC. The lowest of carbon stock had 0.42 Tg which was about 0.32% of total carbon with Grey-Brown GSG, which occupy the smallest area (0.05%). Soil organic carbon amounts were high to low respectively Chestnut 14.90, Hydromorphic 12.00, Alluvial Coast 8.00 Alluvial 7.80,Colluvial 7.55, Non-Calcareous Brown 6.45, Brown Forest 6.00, Regosols 5.60, Non-Calcareous Brown Forest 5.56, Brown 4.36 and Grey-Brown soils 4.36 kg C m^{-2} . Hydromorphic, Alluvial Coast, Alluvial, Cooluvial, Brown, Brown Forest, Non-Calcareous Brown Forest, Regosols GSG, together were responsible for 31.69 Tg of carbon in the city. Soil organic carbon stocks in the same soil groups were determined 73.87, 3.66, 0.76, 6.40, 1.87, 25.95, 0.57, 5.45, 1.17, 11.81 and 0.42 Tg respectively (Table 1).

Great Soil Groups of Van can be separated three groups according to their SOC amounts; (i) Brown, Grey-Brown, Non-Calcareous Brown Forest and Regosols between 4.00-5.99 kg C m^{-2}, (ii) Alluvial, Alluvial Coast, Brown Forest, Non-Calcareous Brown and Colluvial GSG between 6.00-8.00 kg C m^{-2}, (iii) Hydromorphic and Chestnut Great Soil Groups between 12.00–14.90 kg C m^{-2} (Fig. 2). Sakin (2010) have used the similar categorizations for SOC and SIC in Southeast Anatolia Region (SAR) soils.

Batjes (1996) reported that mean amount SOC soils of the world was 9.6 and 11.1 kg C m-^{2} (0-1 m depth) for Kastanozems and Vertisols. Brahim et al. (2010) estimated that the mean SOC for Tunusian soils in the 0-1 m layer was 4.04, 13.88 and 15.92 kg C m-^{2} for Lithosol, Pozoluvisals and Luvisols, respectively. The total SOC amounts of the Van Plain were comparable, regardless or the method used for their estimation. The estimated SOC stocks were similar to the amount 6.38 to 10.04 kg C m-^{2} reported by Brahim et al (2010) and Sakin et al (2010a,c,d) 4.04 to 13.38 kg C m-^{2} at the depth of 0-100 cm.

Table 1. Carbon stocks (Tg) soils of East Anatolia Region Great Soil Groups.

Great Soil Groups (GSG)	Area (ha)	Distribution (%)	SOC (kg m^{-2})	SOC stock (Tg)
Alluvial	81 996.70	4.30	7.80	6.40
Alluvial Cost	9 534.50	0.50	8.00	0.76
Grey-Brown	9 534.50	0.50	4.36	0.42
Hydromorphic	30 510.40	1.60	12.00	3.66
Brown	270 779.80	14.20	4.36	11.81
Brown Forest	9 534.50	0.50	6.00	0.57
Chestnut	495 794.00	26.00	14.90	73.87
Non-Calcareous Brown	402 355.90	21.10	6.45	25.95
Non-Calcareous Brown Forest	20 975.90	1.10	5.56	1.17
Colluvial	24 789.70	1.30	7.55	1.87
Regosols	97 251.90	5.10	5.60	5.45
Lakes	193 400.00	10.850	-	-
Other area	453 842.20	12.950	-	-
Total	2 100 300	100	-	131.92

The factors affecting carbon amounts are climate, clay and lime content of soil and slope. A higher SOC of humid region soils as compared to lower SOC of arid soils could be explained by higher vegetative input, higher rainfall and higher clay content (Bruke et al. 1989). Clay protects SOC from decomposition on developing stable-clay organic complex (Kögel-Knabner et al. 2008). But, this relationship carbon-clay doesn't occur every time. For example, the semi-arid region should have higher SOC than higher rainfall of humid region (Singh et al. 2003a,b).

Kögel-Knaber et al. (2008) expresses that clay, Fe-Al oxide and hydroxides compounding with carbon in soil create organo-mineral complexes and this save the carbon against the oxidation. Singh et al. (2003a, b) says that this relation between clay and carbon is not seen every time. If this situation was permanent, the SOC amount of Vertisol GSGs would be higher than other GSGs. Velayutham et al. (2002) states that, the positive effects of 2:1 type clay minerals on Vertisol soils decrease because of excessive cultivation.

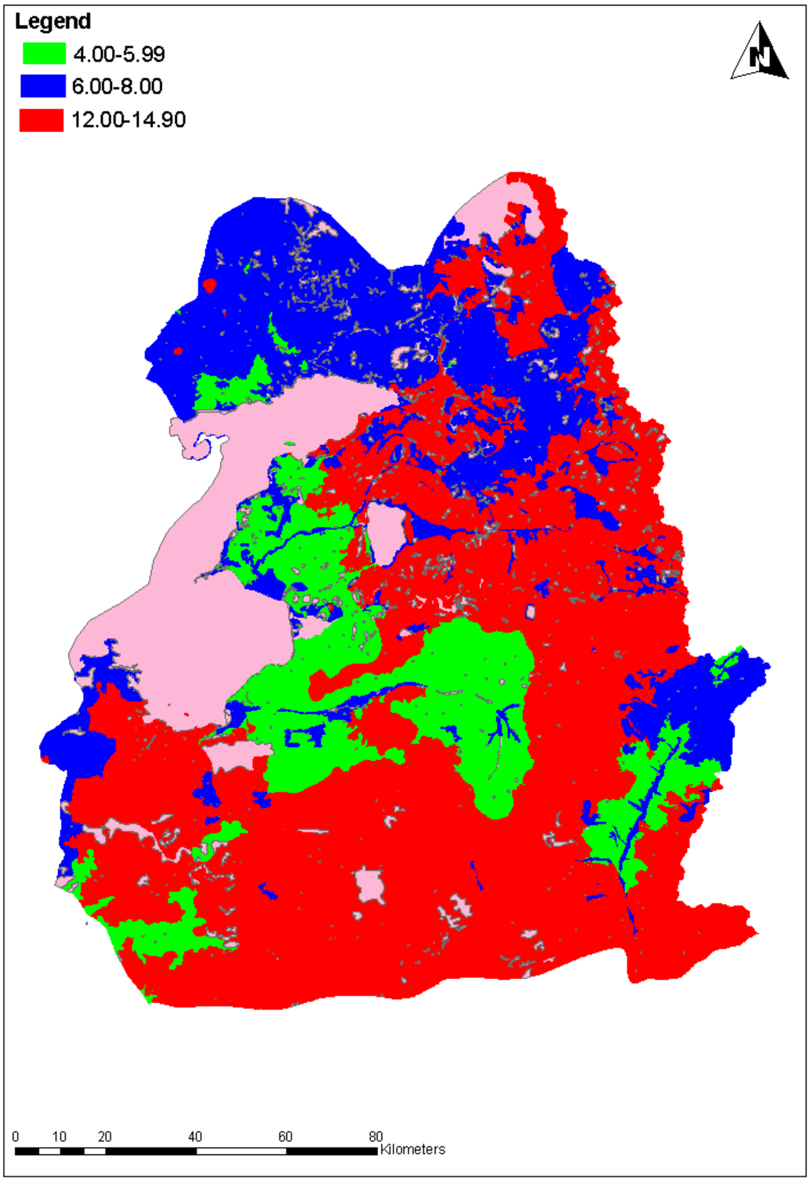

Figure 2. SOC amounts Great Soil Groups (kg C m^{-2})

CONCLUSIONS

The present data showed that rainfall, clay content and land use pattern influenced SOC amounts and stocks. Intensive agriculture technique without proper management in the areas was the cause of rapid SOC decomposition compared to no-till agriculture soils.

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