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Effect of Different Land Uses (Mature and Young Fir Stands-Pasture and Agriculture Sites) on Soil Organic Carbon and Total Nitrogen Stock Capacity in Kastamonu Region

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Abstract: Land use strongly influences soil properties, and unsuitable practices lead to degradation of soil and environmental quality. Main aim of this study was to assess the impact of different land uses on some soil properties, soil organic carbon (C) and total nitrogen (N) contents and stock capacities in Kastamonu, Turkey. Mature and young fir stands and adjacent pasture and agriculture sites were used to study the differences in some soil properties and soil organic C and N contents and stock capacities. Mineral soil samples were taken from two soil depths (the upper soil part 0-10 cm and the lower soil part 10-20 cm), and analysed for pH, texture, water holding capacity (WHC), salt, lime, organic matter (OM), P and K concentrations, total soil organic C and total N content, and stock capacities. Results showed that for the soil upper part, the agriculture site had the lowest clay, silt, WHC, pH, P, K and OM, whereas it had the highest sand content. Most of these soil factors were highest in the soil from mature fir stands. As for the lower soil part, there were no clear indications among the land-use types. However, the agriculture site had the highest clay, silt and soil pH, whereas the pasture site showed the lowest clay, silt, P and K contents. The mature and young fir stands always showed the highest mean soil C and N contents and stock capacities either at the upper or the lower soil parts, followed by the pasture and the agriculture sites. However, all soil depth was considered (0-20 cm), mean soil organic C stock capacity was highest for the pasture site (50.2 Mg C ha^{-1}), followed by the young fir site (48.6 Mg C ha^{-1}), the mature fir site (47.4 Mg C ha^{-1}), and the agriculture site (32.3 Mg C ha^{-1}). Mean soil total N stock capacity was highest for the young fir site (5.61 Mg N ha^{-1}), followed by the pasture site (5.09 Mg N ha^{-1}), the mature fir site (4.45 Mg N ha^{-1}), and the agriculture site (3.33 Mg N ha^{1}).
Keywords: Carbon and nitrogen stock, Forest, Pasture, Agriculture site, Land use type

Kastamonu Yöresinde Farklı Arazi Kullanımının (Yaşlı ve Genç Göknar Meşcereleri-Mera-Tarım Alanları) Toprak Organik Karbon ve Toplam Azot Depolama Kapasitesine Etkileri

Özet: Arazi kullanımı önemli derecede toprak özelliklerini etkilemekte ve uygun olmayan uygulamalar toprağın ve çevre kalitesinin bozulmasına yol açmaktadır. Kastamonu Bölgesinde gerçekleştirilen bu çalışmada, farklı arazi kullanımının bazı toprak özellikleri, organik karbon ve azot miktarları ve depolama kapasiteleri üzerine olan etkilerinin araştırılması amaçlanmıştır. Bu amaçla, yaşlı ve genç göknar meşçereleri ile bitişiğindeki tarım ve mera alanların bazı toprak özellikleri ile karbon ve azot depolama kapasiteleri belirlenmiştir. Mineral toprak örnekleri üst (0- 10 cm) ve alt (10-20 cm) olmak üzere iki farklı toprak derinlik kademesinden alınmış olup, sırasıyla bu topraklarda tekstür, su tutma kapasitesi, elektriksel iletkenlik, kireç miktarı, organik madde, fosfor (P) ve potasyum (K) konsantrasyonları yanında toplam organik karbon ve azot miktarları analiz edilmiştir. Sonuçlar incelendiğinde, üst toprak kısımlarında, en düşük kil, toz, su tutma kapasitesi, pH, P, K ve organik madde miktarı ile en yüksek kum miktarı tarım alanları topraklarında tespit edilmiştir. Üst toprak özelliklerinin çoğunluğu yaşlı veya genç göknar meşcerelerinde daha yüksek belirlenmiştir. Alt toprak özellikleri değerlendirildiğinde ise, farklı arazi kullanımları arasında belirgin bir farklılık tespit edilmemekle beraber, tarım alanları topraklarının en yüksek kil, toz ve pH değerlerine, mera alanları topraklarının ise en düşük kil, toz, P ve K miktarına sahip olduğu görülmüştür. Yaşlı ve genç göknar meşcerelerinin üst ve alt toprakları en yüksek organik karbon ve azot miktarı ve depolama kapasitesine sahip olurken, bu değerleri mera alanları ve tarım alanları izlemiştir. Bununla beraber, tüm toprak derinliği değerlendirildiğinde (0- 20 cm), ortalama toprak organik karbon depolama kapasitesi en yüksek mera alanlarında (50.2 Mg C ha^{-1}), bunu sırasıyla genç göknar meşcereleri (48.6 Mg C ha^{-1}), yaşlı göknar meşcereleri (47.4 Mg C ha^{-1}) ve tarım alanları (32.3 Mg C ha^{-1}) takip etmiştir. Ortalama toplam azot depolaması ise en yüksek genç göknar meşcerelerinde (5.61 Mg N ha^{-1}) belirlenirken, bunu sırasıyla mera alanları (5.09 Mg N ha^{-1}), yaşlı göknar meşcereleri (4.45 Mg N ha^{-1}) ve tarım alanları (3.33 Mg N ha^{-1})'na ait topraklar izlemiştir.
Anahtar Kelimeler: Karbon ve azot depolama, Orman, Mera, Tarım, Arazi kullanım durumu

Introduction

There is strong evidence that the expanding human use and alteration of the biosphere for food, fuel and fibre is contributing to increasing atmospheric concentrations of greenhouse gases (GHGs). The dominant gas of concern in this source category is C dioxide (CO_2). Soils play significant roles in global C cycle. It was estimated that soils have contributed as much as 55 to 878 billion tons (GT) of C to the total atmospheric CO_2 (Kimble et al., 2002).

Land-use changes, and especially agriculture and cultivation of previously forested land, reduce significantly the soil quality (e.g., changes in soil organic matter (SOM) content and decomposition rates, changes in soil chemical and physical properties), leading to a permanent degradation of land productivity (Islam et al., 1999; Singh and Lal, 2005; Batlle-Aguilar et al., 2011). Estimates of CO_2 emissions due to land-use change vary considerably because humans interact with the land in a myriad of ways. Estimates vary due to uncertainties in annual forest clearing rates, the fate of the land that is cleared, the amounts of biomass (and hence C) contained in different ecosystems, the modes by which CO_2 is released (e.g., burning or decay) and the C released when soils are disturbed (IPCC, 1996). The increasing N availability due to the production and application of nitrogenous fertilizer, and fossil fuel combustion (Hobbie 2008) would also impact C and N cycling in terrestrial ecosystems (Jiang et al., 2010).

Changes in soil C and N after conversion of forests to agriculture site and pasture vary greatly among sites. Differences in C and N storage between pasture, pasture and forest sites are attributed to variations in vegetation type, tree stand age and physical properties of soils (Osher et al., 2003; Sariyildiz et al., 2016).

Forest ecosystems only cover 30% of the land areas, but contain 81% of the terrestrial C biomass (Lecointe et al., 2006). In addition, forests accumulate 20 to 100 times as much C per unit area as agricultural land and are 20 times more productive than pasture (Houghton, 1990; Curtis et al., 2002). Several reviews estimated that loss of soil C after cultivation of native soil ranges between 20% and 50% (Arevalo et al., 2009). Davidson and Ackerman (1993) suggested that nearly all C lost from soil occurs within 20 years, and that most occurs within 5 years after initial cultivation. Agricultural practices and land-use change contribute about 18–20% of the total anthropogenic emissions of CO_2 each year (Dumanski, 2004). This accounts for approximately 60% of total emissions from the underdeveloped countries, 33% from developing countries, and up to 10% from developed countries (Baumert et al., 2004). The need for an accurate inventory of C and N stocks, the capacity of forest to accumulate C and N and also the variations in C and N stocks with land-use types was emphasised at the Helsinki (1993) and Kyoto (1997) conferences (Lecointe et al., 2006).

In order to contribute to this issue in the light of the above explanations in this paper, we set up a study in the northeast of Turkey to explore the differences in some soil properties, soil organic C and N contents and stock capacities according to land use types using young and mature fir stands and adjacent pasture and agriculture sites.

Material and Methods

Site Description and sampling

The study was carried out in Kastamonu, northwest of Turkey (41°23′19″ N, 33°46′57″ E) (Fig. 1). The altitudes of the studied areas were 800 m above sea-level (Tab. 1). The aspect of the studied site was Northwest (NW). In the study area, terrestrial climatic conditions exist, i.e. winters are long, cold and snowy, whereas summers are short and warm. The seasonal and daily temperatures show big extreme values and precipitation is generally low. The weather data for 1975-2010 (Kastamonu Meteorology Station, at 800 m) indicate that precipitation averages 490 mm annually. Average monthly temperatures range from 20.2 ^{o}C in July to -0.8 ^{o}C in January. The differently sized granite/quartz is to be seen in the studied area. Physical morphology and tree species distribution of the study site is shown in Figure 2.

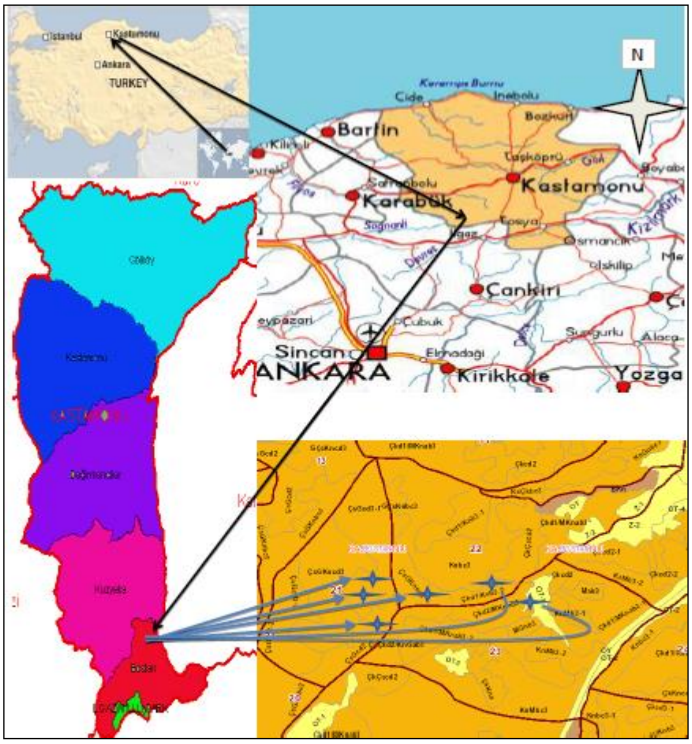

Figure 1: Location of the study site

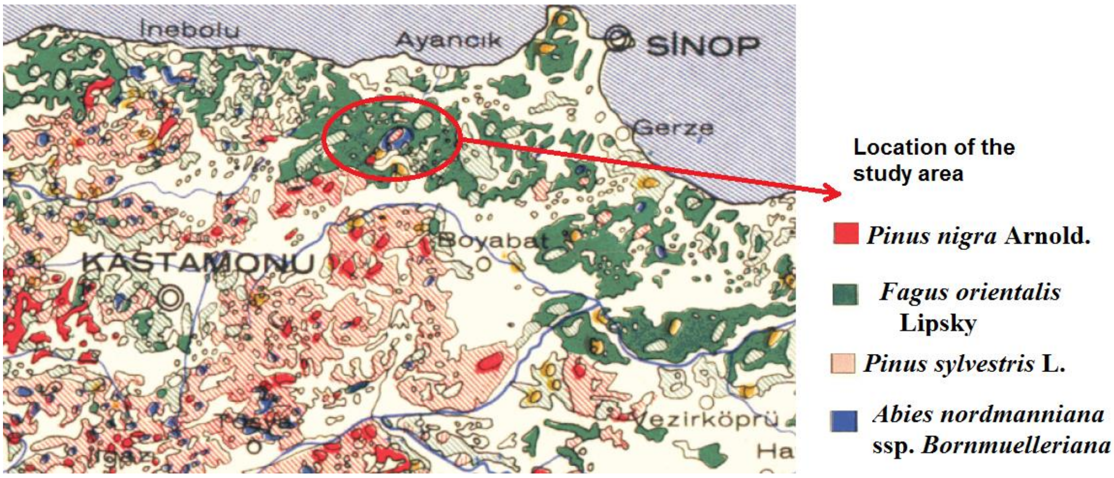

Figure 2: Naturally grown tree species in the study area

The study area consists of a variation of broadleaf and conifer stands with ages between 40 and 150 years. Mature and young Kazdağı fir (sin:*Abies nordmanniana subsp. equi-trojanı* (Steven) Spach)- previously named as Uludağ firs (*Abies nordmanniana* ssp. *bornmuelleriana*) stands of approximately 85 and 45 year-old respectively and adjacent pasture and agriculture sites situated at the altitude of 800 meters were chosen to get soil samples. We selected the mature fir stands with age of approximately 80-90 years, homogenous soils, the same slope position (NW) and a location in the centre of the forest.

Soil sampling was conducted in the autumn of 2012 and spring of 2013. Three adjacent subplots (replicates) (20 m x 20 m) were identified and sampled for each stand. Humus form of the stands was moder-like. Mineral soil sampling was confined to the upper 20 cm of soils, as changes in soil C and N were expected to occur first here. A soil core device with an inner diameter of 5 cm was used for soil sampling to a depth of 20 cm. Mineral soil sample cores were taken from 0–10 cm and 10–20 cm soil depth, and passed through a 2 mm sieve to remove stones and gravel.

Soil Analysis

Soil pH was measured in a 1:2.5 mixture of deionized water and soil using a glass calomel electrode (Origon 420 digital pH meter), after equilibration for 1h. Soil texture analyses were done on soil samples from the 0–20 cm layer. Soil pH was determined for soil samples from the 0–20 cm layer. The moisture content of soils was calculated by weight loss after drying aliquots of ca. 10 g of soil for 24 h at 105 ^oC. Soil texture was determined using a Bouyoucos hydrometer in a soil suspension of 50 g of soil in 1 L of H_2O (Gülçür 1974 modified by Bouyoucos, 1962). Samples were pre-treated with %10 ammonium hydroxide (NH_4OH) to remove organic matter and NaHMP was used as a dispersal agent to minimize foaming. Bulk density was determined by weight loss after drying the undisturbed soil core. Soil C content was determined with using a Leco dry combustion element analyser. Total N was determined by Kjeldal digestion (Allen 1989) followed by analysis of ammonium by the indophenols method using an auto-analyser samples for 2 days at 105 ^oC. The SOC or N stock capacity were calculated by multiplying soil volume, soil bulk density, and SOC or total N content and expressed as Mg ha^{-1} (Lee et al. 2009). Soil mass is calculated as:

$Mi = BDi \times Ti \times 10^4$

where Mi is dry soil mass (Mg ha^{-1}), BDi is bulk density (Mg m^{-3}), Ti is the thickness of the ith soil layer (m), and 10^4 is a unit conversion factor (m^2 ha^{-1}). The fixed depth (FD) determination of areal C or (N) stock is calculated as:

Ci or Ni;fixed = Concentration Ci or Ni x Mi where Ci;fixed is the C or N mass to a fixed depth (kg C or N ha^{-1}) and Concentration Ci or Ni is the C or N concentration (kg C or N Mg^{-1}).

Data analysis

Analysis of variance (ANOVA) was applied to determine the differences in some soil properties, soil C and N contents and stock capacities between three land-use types (mature fir, young fir, pasture and agriculture site) using the SPSS program (Version 11 for Windows). Following the results of ANOVAs, Tukey's honestly significant difference (HSD) test ($\alpha = 0.05$) was used for significance.

Results

Soil properties

Mean soil texture, water holding capacity, soil pH, electric conductivity (EC), lime ($CaCO_3$), Phosphorus (P), Potassium (K) and soil organic matter of mature and young fir, pasture and agriculture sites are given in Table 1. The single effects and interactions of land-use type and soil depths of soil properties are shown in Table 2. Soil pH, soil texture (sand, clay and silt), water holding capacity and organic matter content significantly ($P<0.001$) differed among the land-use types. Only soil K content and organic matter had a significant ($P<0.05$) variation with the soil depths. Soil sand, silt, K and organic matter content also had a significant land-use type x soil depth interaction ($P<0.05$), indicating that soil sand, silt, K and organic matter show different trends according to soil depths on different land-use types (Table 2).

For the soil upper part, the agriculture sites had the lowest clay, silt, water holding capacity, pH, P, K and organic matter, whereas the agriculture sites had the highest sand content. Most of these soil factors were highest in the soil from mature fir stands (Table 1). As for the lower soil part, there were no clear indications among the land-use types. However, the agriculture sites had highest clay, silt and soil pH, whereas the pastures showed the lowest clay, silt, P and K contents (Table 1).

Mean soil C and N content and stock capacity of mature and young fir, pasture and agriculture sites are given in Table 3. The single effects and interactions of slope positions and soil depths of C and N content and stock capacity are given in Table 4. Soil C and N content and stock capacities showed significant ($P<0.001$) variations between the land-use types and between the soil depths (Table 4). Except, soil total N stock capacity, other three factors (Soil organic C, N and SOC-stock capacity) had a significant ($P<0.001$) land-use type x soil depth interaction, indicating that they show different trends according to soil depths on different land-use types (Table 4).

Mature and young fir stands always showed highest mean soil C and N contents and stock capacities either at the upper or the lower soil depths, followed by the pastures and the agriculture sites (Table 2). However, all soil depth was considered (0-20 cm), mean soil organic C stock capacity was highest for the pasture site (50.2 Mg C ha^{-1}), followed by the young fir site (48.6 Mg C ha^{-1}), the mature fir site (47.4 Mg C ha^{-1}), and the agriculture site (32.3 Mg C ha^{-1}). Mean soil total N stock capacity was highest for the young fir site (5.61 Mg N ha^{-1}), followed by the pasture site (5.09 Mg N ha^{-1}), the mature fir site (4.45 Mg N ha^{-1}), and the agriculture site (3.33 Mg N ha^{-1}).

Discussion and Conclusion

This present study has shown that land-use type can significantly affect soil properties, soil organic C and total N contents and also stock capacities. Many researchers (for example; Guo and Gifford, 2002; Arevalo et al., 2009) have shown that land use changes affect soil properties, soil organic C and N, and thus, nutrient cycling dynamics. Changing soil properties means also changing the type of vegetation, altering even more the concomitant nutrient cycles. The example most widely observed is the change from forest to agricultural soils, due to increasing anthropogenic demands for food production. Among the four land-use types studied in this present study, the agriculture sites showed the lowest soil properties (clay, silt, water holding capacity, pH, P, K and organic matter) and soil organic C and N content and stock capacity. From this study, it emerged that about 40 years of conventional agricultural use, of a native fir forest soil, had resulted in a significant decrease of soil organic C and total N in the top 10 cm of soil. Agricultural practices generally cause changes in soil structure, compromising aggregation and porosity, leading to a soil structure decline (Lal, 2003). Tillage practices like mechanical mixing compact and reduce the size of aggregates and fills pore spaces with fines. Soil tillage and ploughing also promote redistribution of residues and their decomposition. As a result, soil C and N pools are depleted and soil fertility is lost. Soil C is oxidized to CO_2 and lost to the atmosphere contributing to the increase of greenhouse gases in the atmosphere (Bruce et al., 1999). Moreover, tillage improves soil aeration, destroys macro-aggregates and changes the hydrological cycle, with an increase of the respiration rates and ultimately an additional depletion of the C pool (Reicosky et al., 1997). Previous research by Houghton (1999) estimated a SOC loss (from 1 m depth) of 51 Mg C ha^{-1} when boreal forests were converted to agricultural land-use. All studies that focused on the effects of land conversion from forest to cultivated land concluded that land-use change induces a reduction of the available soil C and a decrease in its quality. The maximum rate of loss occurs during the first 10 y of cultivation, with total C decrease up to 30% (Davidson and Ackerman, 1993; Murty et al., 2002) followed by reduced but still significant reduction rate (Motavalli et al., 2000). Furthermore, it was reported that the loss rate is highly variable and influenced by several factors such as the native vegetation, climate, soil type and management practices (Davidson and Ackerman, 1993; Bruce et al., 1999).

Land use changes significantly affect soil bulk densities and the C:N ratios. These factors also induce SOC variation. Organic C content shows a negative relationship with bulk density as seen in this present study (Table 2 and Table 3). This relation was observed by Sonja et al. (2005) in the field when organic C content increased as bulk density declined. Evrendilek et al. (2004) studied by the conversion of pasture into cropland indicated the increase of bulk density and the decrease of SOC. Prévost (2004) deliberated, some other soil properties (i.e. total porosity and C:N ratio), affected root development and were closely related to soil organic matter concentration.

Forests sequester and store more C than any other terrestrial ecosystem and are an important natural ‘brake’ on climate change. When forests are cleared or degraded, their stored C is released into the atmosphere as carbon dioxide (CO_2). The literature indicates a mixture of findings for soil C stocks ranging from increases to decreases as a result of conversion of forest to pasture. Some of the varied results can be explained by correction or lack of correction for factors such as soil compaction and clay content, and the effect of the short-term seasonal cycles. Factors like sampling depth, number of samples, soil type, dominant vegetation and the quantity and type of C previously present are of fundamental importance to calculating mean values for use in simulations of C emissions and uptakes. Contrasting with the conversion from forest to cultivated land, controversy exists when the change is from forest to pasture lands. The overall change in soil C has been shown to be either positive or negative. For instance, de Moraes et al. (1996) found an increase up to 20% in total soil C 20 y after the change in land use, while Veldkamp (1994) reported a net soil organic C loss up to 18% after 25 y. Johnson (1992) also observed that changes in soil C in both land-use cultivation and pasture were associated with changes in soil N. Reiners et al. (1994) found that the transformation of forest land to pasture led to important changes in the N cycling. For example, the ammonium (NH_4^+) pool was larger in pasture lands while the nitrate (NO_3^-) pool was less important in pasture than forest lands. This is consistent with a low rate of plant uptake of NH_4^+ and slow nitrification rates (Vitousek and Sanford, 1986).

In conclusion, the convention of a forest area to agriculture land-use can significantly reduce the soil quality and soil organic C and total N stock capacities. Land use changes should include long term practices to avoid the loss of soil properties, contributing to the maintenance of optimal conditions for long term agricultural production. Crop rotation is an important management practice to avoid soil C losses following conversion from forest to agricultural land. Furthermore, some researchers (Bruce et al., 1999) proposed that a diminution of tillage processes minimizes soil erosion and decomposition rates, and thus soil C losses.

Table 1: Differences in soil properties (0-10 cm and 10-20 cm soil depths) between mature fir, young fir, pasture and agriculture sites. Different letters indicate significant differences between the different land use type at each soil depth ($P<0.05$, n=15)

Land Use Type	Soil Depth (cm)	Clay (%)	Silt (%)	Sand (%)	WHC (%)	EC	pH	$CaCO_3$ (%)	P (Kg/ha)	K (Kg/ha)	Organic matter (%)
Forest (mature fir)	0-10	23a	11b	65c	73c	0,010	5,49a	1.47	0,344b	6,82b	4,52d
Forest (young fir)		28b	9a	63b	72c	0,010	5,72b	1,47	0,365b	6,74b	3,79c
Pasture site		32b	12b	57a	64b	0,007	5,62ab	1,47	0,424c	4,75a	3,03b
Agriculture site		21a	13b	66c	58a	0,011	6,05c	1,47	0,268a	4,48a	2,15a
Forest (mature fir)	10-20	25b	11b	64b	70c	0,008	5,33a	1,47	0,298b	4,23b	2,63bc
Forest (young fir)		26b	9a	65b	64b	0,009	5,65b	1,47	0,279a	5,40c	2,78c
Pasture site		17a	9a	74c	60ab	0,006	5,59b	1,47	0,266a	3,76a	2,46b
Agriculture site		34c	13b	53a	54a	0,009	6,24c	1,47	0,286ab	4,53b	1,64a

Table 2: ANOVA of soil properties

	Sources	SS	df	MS	F	Eta squared
pH	Land Use Type (LUT)	3,582	3	1,194	16,046***	,534
	Soil Depth (SD)	,004	1	,004	,051	,001
	LUT x SD	,207	3	,069	,927	,062
	Error	3,125	42	,074		
Sand (%)	LUT	744,6	3	248,2	23,660***	,780
	SD	10,92	1	10,9	1,041	,049
	LUT x SD	119,7	3	39,9	3,804*	,363
	Error	209,8	20	10,49		
Clay (%)	LUT	577,6	3	192,6	25,572***	,793
	SD	1,11	1	1,112	,148	,007
	LUT x SD	39,08	3	13,02	1,730	,206
	Error	150.6	20	7,53		
Silt (%)	LUT	39,80	3	13,3	6,234**	,483
	SD	4,931	1	4,93	2,316	,104
	LUT x SD	25,46	3	8,48	3,987*	,374
	Error	42,57	20	2,12		
WHC (%)	LUT	1842,4	3	614,1	9,533***	,405
	SD	263,3	1	263,3	4,088	,089
	LUT x SD	49,12	3	16,37	,254	,018
	Error	2705,6	42	64,41		
Salt	LUT	6,768	3	2,256	2,388	,780
	SD	2,571	1	2,571	2,722	,049
	LUT x SD	6,768	3	2,256	2,388	,363
	Error	,000	42	9,44		
P (Kg/ha)	LUT	2,438	3	,813	,510	,035
	SD	5,257	1	5,257	3,303	,073
	LUT x SD	4,163	3	1,388	,872	,059
	Error	66,85	42	1,592		
K (Kg/ha)	LUT	2100,9	3	700,3	1,628	,104
	SD	1982,3	1	1982,3	4,610*	,099
	LUT x SD	985,4	3	328,4	,764	,052
	Error	18062,3	42	430,0		
OM (%)	LUT	20,22	3	6,74	6,938**	,331
	SD	11,32	1	11,32	11,651**	,217
	LUT x SD	4,678	3	1,55	1,605	,103
	Error	40,808	42	,972		

Asterisks refers the level of significance: *, P<0.05; **, P<0.01; ***, P<0.001.

Table 3: Mean soil bulk density (Mg m^{-3}), soil C and N contents and stock capacity (%), and C/N ratios in two soil depths (0-10 cm and 10-20 cm). Different letters indicate significant differences between the land-use types at each soil depth (P<0.05, n=15).

Land-use type	Depth	Bulk density (g/cm^{3})	SOC (%)	STN (%)	SOC- stock capacity (Mg C ha^{-1})	STN-Stock capacity (Mg N ha^{-1})	C/N ratio
Forest (mature fir)	0-10	1.07a	2.56b ±0.70	0.23b ±0.04	27.4c ±7.51	2.47b ±0.40	11 : 1
	10-20	1.29a	1.55bc ±0.73	0.15c ±0.02	20.0b ±9.42	1.98b ±0.32	7 : 1
	0-20	1.18a	2.06c ±0.56	0.19b ±0.02	47.4b ±13.4	4.45b ±0.48	11 : 1
Forest (young fir)	0-10	1.22b	2.20a ±0.85	0.26b ±0.03	26.8bc ±10.4	3.11c ±0.42	8 :1
	10-20	1.35b	1.61c ±0.27	0.19c ±0.04	21.7b ±3.60	2.50c ±0.56	9 :1
	0-20	1.29b	1.90bc ±0.56	0.22c ±0.03	48.6bc ±13.9	5.61d ±0.88	9 :1
Pasture	0-10	1.45c	1.76b ±0.43	0.21b ±0.03	25.5b ±6.27	2.97c ±0.38	8: 1
	10-20	1.73d	1.43b ±0.22	0.12b ±0.03	24.7c ±3.82	2.12b ±0.52	12: 1
	0-20	1.59c	1.59b ±0.33	0.16b ±0.02	50.2c ±10	5.09c ±0.90	10: 1
Agriculture d site	0-10	1.42c	1.25a ±0.25	0.14a±0.02	17.7a ±3.6	1.92a ±0.34	9: 1
	10-20	1.53c	0.95a ±0.51	0.09a±0.03	14.6a ±7.9	1.42a ±0.32	11: 1
	0-20	1.48c	1.10a ±0.33	0.11a±0.02	32.3a ±10	3.33a ±0.53	10: 1

Table 4: ANOVA of soil organic C and total N stock capacity

	Sources	SS	df	MS	F	Eta squared
SOC (%)	Land Use Type (LUT)	5,923	3	1,974	5,147**	,279
	Soil Depth (SD)	2,957	1	2,957	7,709**	,162
	LUT x SD	1,218	3	,406	1,058	,074
	Error	15,34	40	,384		
STN (%)	LUT	,055	3	,018	16,666***	,562
	SD	,039	1	,039	35,705***	,478
	LUT x SD	,002	3	,001	,562	,041
	Error	,043	40	,001		
SOC- stock capacity (Mg C ha^{-1})	LUT	1733,8	3	577,9	7,585***	,363
	SD	2350,7	1	2350,7	30,851***	,435
	LUT x SD	2936,6	3	978,8	12,847***	,491
	Error	3047,8	40	76,19		
STN-Stock capacity (Mg N ha^{-1})	LUT	5,853	3	1,951	12,524***	,484
	SD	3,626	1	3,626	23,276***	,368
	LUT x SD	,212	3	,071	,453	,033
	Error	6,231	40	,156		

Asterisks refers the level of significance: *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$.

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