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Stocks and annual fluxes of organic carbon in the mineral soil cover of Estonia

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Abstract. Annual cycling of soil organic carbon (SOC) is the main driving force in the formation and functioning of soil cover. Therefore knowledge about it forms the scientific base for sustainable management and ecologically sound soil protection. Systematized parameters of the mean annual cycling of SOC by soils are analysed on the basis of the SOC stock densities (Mg ha^{-1}) of 16 mineral soil groups. The SOC stocks according to soil groups for the soil cover (solum) as a whole and for their epipedon were calculated on the basis of mean SOC densities and their distribution area of soil types. In the Estonian mineral soil cover (32 351 km^2) a total of 323 ± 46 Tg (10^{12} g) SOC is retained; 42% of this is sequestered into stabilized humus, 40% into unstable raw humus, and 18% into forest (grassland) floor and shallow peat layers. Of the total SOC stock, 75% is situated in biologically active epipedons and 25% in subsoil. The annual SOC inputs and outputs in natural soils, which were calculated on the basis of annual productivity, ranged from 0.2 to 3.6 Mg ha^{-1} yr^{-1}. The influence of land management peculiarities on the annual cycling and balance of SOC has been demonstrated by our own experimental research, as well as by data published in the literature. In this work the pedo-ecological causal regularities of SOC sequestration in mineral soil cover (SOC concentration, soil thickness, moisture regime, texture, carbonate content), and agro-technological possibilities for its regulation (crops and their rotation, level of subsidization and soil amelioration) are discussed.

Key words: carbon retention capacity, carbon stock, carbon turnover, land use, pedo-ecological regularities.

INTRODUCTION

Data on the annual cycling of soil organic carbon (SOC) in certain soil types and land use conditions form a good basis for understanding the peculiarities of soil formation, development, and functioning (Kern et al., 1998; Kätterer et al., 2004). Systematized parameters of mean annual turnover of SOC according to soils and land use are needed for the introduction of sustainable management and ecologically sound protection of soil cover (Körchens et al., 1998; Lal et al., 1998; Halvorson et al., 2002).

Soil cover (solum), which forms an inseparable functional part of terrestrial ecosystems, determines in natural areas the floristic composition of plant cover (site type), mean annual productivity, and annual litter fall intensity onto the soil

(Kõlli, 1988). According to the peculiarities of soil mineral composition, actual humus status, and organic matter influx, the specific to soil-type associations organisms destructing soil organic matter are formed.

Besides the direct influence of soil cover on an ecosystem and on its plant cover, a clearly visible feedback of plant cover and soil fauna on soil properties exists. However, this feedback influence is concentrated mainly in the epipedon, in which the annual litter fall is accumulated, most soil organisms are acting, and most soil processes are initiated. In connection with this, the established epipedon type serves as a good indicator in evaluating the material cycling characteristics of ecosystems (Kõlli et al., 2009). Therefore, natural ecosystems specific to certain soil types with optimal (sustainable on a long-time scale) floristic and faunal richness also serve as good biodiversity examples (models) for particular pedo-ecological conditions.

Certain epipedon properties that exist in natural conditions also persist after land use change (cultivation). Only high-input land management (drainage, fertilization, liming) completely overshadows the soil-type specific relationships and characteristics formed in natural conditions. As a result of this, an *anthric* epipedon is formed.

The main task of this study is to analyse the annual cycling and balance of SOC (Mg SOC ha^{-1} yr^{-1}) in the main Estonian mineral soil groups in natural (or weakly influenced) and cultivated conditions. As annual phytoproductivity and therefore annual SOC cycling largely depend on soil humus status and soil–plant system functioning (Paustian et al., 1997; Smith et al., 1998), our analysis was realized on the basis of data on soil SOC stocks and productivity parameters. Data on the same areas are presented in detail in a previous publication (Kõlli, 1992).

MATERIALS AND METHODS

The quantitative characteristics of humus status of soils and annual phytomass fluxes of plant cover originate from the soil profile horizons database (DB) 'Pedon' and humus status research transect DB 'Catena'. These DBs (formed since 1967) were created by us for the characterization of the main Estonian soil types at ecosystem level and for studying their functioning in typical areas of their distribution (Kõlli, 1988).

In these DBs, SOC stocks (Mg ha^{-1}) were calculated according to soil horizons on the basis of SOC content (g kg^{-1}) and soil bulk density. The SOC content in fine-earth soil samples (particle diameter <1.0 mm) was determined by the Tyurin method, that is by wet digestion of organic carbon with acid dichromate (Vorobyova, 1998). In 358 soil profiles, the SOC content was determined for each horizon, but for 322 profiles (erosion-affected soils) the subsoil SOC content was determined in only 10–15% of cases.

Bulk density was determined for mineral soil horizons with 50 cm^3 metallic cylinders, and for forest floor and thin *histic* horizons using a 25 cm × 40 cm

(0.1 m^2) metallic frame. Bulk density samples were taken from ~10% of the profiles. The content of the coarse soil fraction (by volume) was determined during fieldwork.

Stocks of SOC were estimated for two soil layers: (1) the epipedon (EP, topsoil or humus cover), which consists of the forest floor and/or humus, raw humus, and peat (*histic*) horizons, and (2) soil cover (SC, or solum) as a whole, whose depth extends from the surface to the unchanged parent material or the C horizon. In the presence of the BC horizon, the thickness of soil cover was measured to the middle of the BC horizon. Therefore SC consists of EP and subsoil (SS, eluvial and illuvial horizons).

The individual profile data were generalized by land use and soil types. The total SOC stocks in mineral soils were calculated on the basis of the distribution area of each soil type and its SOC stock per hectare. The data on the distribution of mineral soils are based on a large-scale (1 : 10 000) soil map (Kokk, 1995). The area covered by mineral soils is about 32 351 km^2 (Kõlli et al., 2009). The distribution of mineral soil cover according to soil groups and land use is presented in Fig. 1. The names and codes of soil groups (Table 1) are given according to the World Reference Base for Soil Resources (WRB; FAO, 2006). To process the collected data, two-way Analysis of Variance followed by Student's test of homogeneous groups was used.

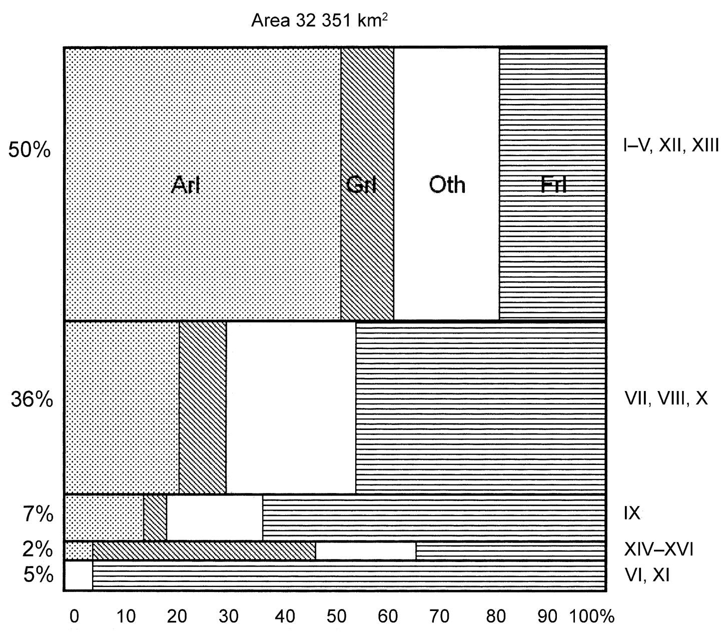

Fig. 1. Distribution of soil groups and land use of Estonian mineral soil cover (32 351 km^2). Soil groups I–XVI, *see* Table 1. Land use: Arl – arable land; Grl – grassland; Frl – forest land, and Oth – other lands.

Table 1. Studied mineral soil groups, their distribution percentage, and mean soil cover thickness

Group No.	Soil or soil association after WRB	n^{a}	% of area	Thickness[b], cm
I	*Gleyic & Rendzic & Lithic Leptosols (skeletic)*	8/12/8	1.6	23.3a
II	*Endogleyic & Mollic Cambisols (calcaric)*	22/46/10	18.1	47.8c
III	*Endogleyic & Cutanic Luvisols (humic)*	12/8/–	8.4	74.2fg
IV	*Fragic & Endostagnic Albeluvisols (umbric)*	19/13/–	12.4	92.6h
V	*Endogleyic & Albic & Umbric Podzols*	28/21/8	6.5	74.3f
VI	*Endogleyic & Carbic & Haplic Podzols*	31/–/–	3.3	64.1e
VII	*Calcic & Mollic Gleysols (calcaric)*	15/6/17	19.0	39.8b
VIII	*Luvic Gleysols (humic, epidystric)*	16/4/3	10.6	55.2cde
IX	*Umbric & Spodic Gleysols (dystric)*	7/2/–	6.7	76.0fg
X	*Saprihistic Gleysols (eutric)*	5/1/–	6.2	46.9bcd
XI	*Epigleyic & Fibrihistic Podzols*	13/–/–	2.1	75.8fg
XII	Eroded *Haplic Cambisols & Aric Regosols*	–/168/–	1.6	54.2d
XIII	Deluvial *Cambisols & Luvisols (colluvic)*	–/154/–	1.2	79.6g
XIV	*Umbric & Histic & Epigleyic Fluvisols (eutric)*	–/–/14	1.2	37.2b
XV	*Subaquatic & Salic Fluvisols & Salic Gleysols*	–/–/8	0.9	15.3a
XVI	*Spolic Technosols & Protic Arenosols*	1/–/–	0.2	25.0

[a] *n* – number of studied profiles of forest/arable/grassland.
[b] The letters following the mean indicate significant differences at $p < 0.05$.
– Not studied.

RESULTS AND DISCUSSION

Stocks of SOC by soil groups

The mean SOC stock densities (Mg ha^{-1}) in the SC of 16 soil groups are given in Fig. 2. In automorphic soils EP SOC stocks varied between 16 and 80 Mg ha^{-1}. Significantly lower SOC stocks were observed in the EP of automorphic *Haplic Podzols* (group V) and in that of arable soils degraded by erosion (XII). Soils with higher carbonate and clay contents had larger EP SOC stocks. In hydromorphic soils the EP SOC stocks were significantly larger compared with automorphic soils (exceptions were strongly podzolized epigleyic and coastal soils). The largest stocks were characteristic of *Histic Gleysols* (EP composed of *sapric* peat).

The retention of SOC in the SC of mineral soils depends to a great extent also on SS thickness and its capacity to retain SOC. The largest SOC stocks in the SS (58–70 Mg ha^{-1}) are characteristic of the humus–illuvial horizon of strongly podzolized epigleyic soils. The smallest SS SOC stocks (5–8 Mg ha^{-1}) are characteristic of thin *Leptosols* and coastal and eroded soils.

Data selection for analysing differences in SOC sequestration was based on the one hand on land use (i.e. forest and arable soils) and, on the other hand, on soil properties (i.e. automorphic and hydromorphic, and calcareous and non-calcareous soils) (Table 2). In most cases (the only exception is the thickness of automorphic soils) the differences between forest and arable SC parameters

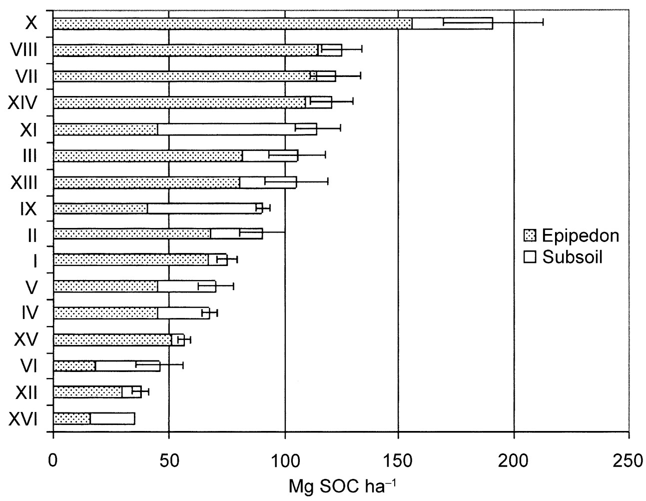

Fig. 2. Stocks of soil organic carbon (Mg ha^{-1}) by soil groups (mean ± SE). Soil groups I–XVI, *see* Table 1. Whiskers (±SE) were calculated for SOC stocks of the whole soil cover (epipedon + subsoil).

(thickness and SOC stocks) are not significant ($p > 0.05$). The thicknesses of SC of calcareous soils are significantly lower, but SOC stocks are significantly higher compared with non-calcareous soils. The main cause of higher SOC stocks in SC is a higher SOC concentration in the EP of calcareous soils. Higher SOC stocks are observed also in hydromorphic soils compared with automorphic soils, but automorphic soils are usually deeper.

Table 2. Comparative analysis of soil cover thicknesses and SOC stocks according to soil moisture conditions, calcareousness, and management

Soil group, characteristic	Parameter	Automorphic soils			Hydromorphic soils		
		n	Thickness, cm	SOC stocks, Mg ha^{-1}	*n*	Thickness, cm	SOC stocks, Mg ha^{-1}
Forest soils	Mwp[a]	79	72.4	76.4	39	63.2	134.0
Arable soils	Mwp[a]	88	63.2	84.6	13	52.2	104.6
Difference	*d*		9.2	8.2		11.0	29.4
Significance of difference	*p*		0.015	0.167		0.063	0.112
Calcareous soils	Mwp[a]	121	46.7	89.4	50	43.4	133.6
Non-calcareous soils	Mwp[a]	120	77.1	63.1	48	66.8	111.4
Difference	*d*		30.4	26.3		23.4	22.2
Significance of difference	*p*		<0.001	<0.001		<0.001	0.050
Automorphic soils	Mwp[a]	241	61.9	76.3	–	–	–
Hydromorphic soils	Mwp[a]		–	–	98	54.9	122.7
Difference	*d*					7.0	46.4
Significance of difference	*p*					0.023	<0.001

[a] Mwp – weighted (by profile number) mean; *d* – difference between Mwp-s.
n – Number of studied profiles.

Pedo-ecological causal regularities of SOC sequestration

In Estonian mineral soils a total of 323 ± 46 Tg (10^{12} g) SOC is retained (Kõlli et al., 2009). The distribution of total SOC stocks in mineral soil cover by land use, SOC quality, soil calcareousness, and vertical distribution is given in Fig. 3.

The SOC retention capacity (Mg SOC ha^{-1}) is the amount of SOC that a specific soil can retain or capture in equilibrated conditions of soil functioning. The actual SOC stocks may coincide with theoretical retention capacity or may be very different from it. By selecting for analyses only soils with typical for an area plant covers, we may obtain results that are very close to the theoretical (benchmark) SOC retention capacity of a soil. The SOC retention capacity of a soil depends, besides SOC concentration, very much on peculiarities of soil type (thickness of EP and SC, moisture regime, texture, and carbonate content) and soil management (Robert, 2001; Rusco et al., 2001).

The SC thickness of mineral soils varied between 15 and 93 cm (Table 1). The greatest SC thickness was characteristic of *Albeluvisols* and some deluvial soils. Thinner SC was found in *Leptosols* and soils formed in coastal and severely eroded areas. In most cases, the EP of arable soils of the same type was significantly

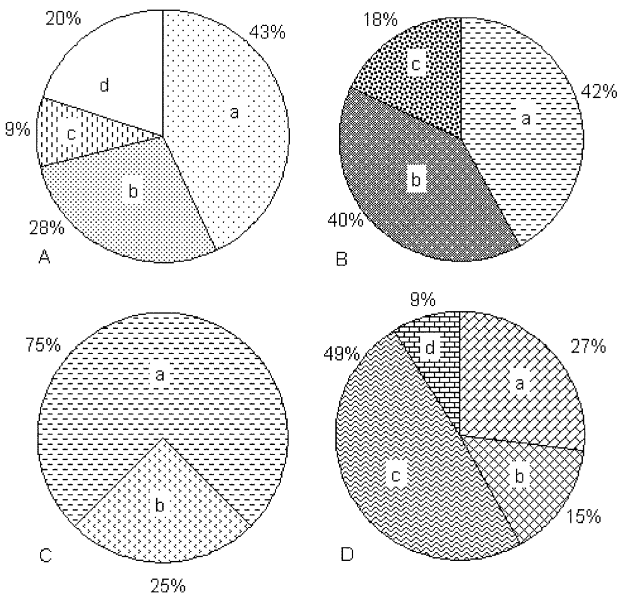

Fig. 3. Distribution of total organic carbon stocks (323 ± 46 Tg) of Estonian mineral soil cover. Features influencing SOC distribution: A – land use: a – forest land, b – arable land, c – grassland, and d – other land; B – kind of soil organic matter: a – stabilized humus, b – raw humus material, and c – forest floor and shallow peat; C – location in soil cover: a – in epipedon and b – in subsoil; D – large soil groups: a – automorphic calcareous, b – automorphic non-calcareous, c – hydromorphic calcareous, and d – hydromorphic non-calcareous.

thicker than that of forest soils. No substantial differences between the thicknesses of the same type of natural and cultivated SC were established.

The influence of soil moisture conditions on soil SOC stocks is clearly visible (DeBusk et al., 2001). In mineral soils the SOC stocks increase in the following sequence of soil moisture conditions: dry < normal moisture < gleyed or endogleyic < gley- or epigleyic < histic gleysoils. The area-weighted average SC SOC density of hydromorphic soils exceeded that of automorphic soils in both calcareous and non-calcareous soil groups (Table 3). Although SOC densities in hydromorphic soils are quite high, their humus quality is low. The humus of hydromorphic soils is unstable, chemically unsaturated, and weakly condensed (Kõlli, 1992; Reintam, 1993).

In the SS of non-calcareous soils, the SOC stocks were relatively higher than in calcareous soils. Low soil calcareousness is connected with soil profile development (forming of illuvial and eluvial horizons). The SOC density of the SS increased from *Leptosols* to *Podzols* and from *Eutric Gleysols* to *Dystric Gleysols*. The influence of soil texture on the SOC retaining capacity has been well described in many works (e.g. Reintam, 1997; Percival et al., 2000; Callesen et al., 2003).

Land use change from forest to arable land causes a decrease in the exogenic SOC stocks and homogenization of SOC concentration (Rosell & Galantini, 1998; Pulleman et al., 2000). Although the epipedon thickness of forest soils is noticeably smaller than in arable soils, another factor, the SOC concentration of forest soils, is generally higher, and, consequently, the SOC stocks in the epipedon and soil cover as a whole may be approximately similar in forest and arable soils. Land use change does not cause substantial changes in the SS fabric and humus status, since the thickness of SC and the level of SOC stocks in the SC remain approximately the same. Compared with SS, EP is always more sensitive to external influences. The functional value of differently sequestrated SOC or of different kinds of soil organic matter can be very different (Table 4). This has to be taken into account in the sustainable management of SOC.

Table 3. Mean (weighted by area) humus status characteristics of large soil groups

Soil group[a]	% of area	Thickness[b]			SOC stocks		
		SC, cm	EP, %	SS, %	SC, Mg ha^{-1}	EP, %	SS, %
AM CAL	29.5	54.8	49.2	50.8	88.6	76.6	23.4
AM NCL	23.9	81.4	24.9	75.1	65.4	62.5	37.5
HM CAL	36.8	44.8	56.0	44.0	134.0	88.2	11.8
HM NCL	9.8	71.7	23.8	76.2	101.7	43.5	56.5
Mineral soils	100.0	59.1	43.4	56.6	101.0	74.2	25.8

[a] Soil groups: AM CAL – Automorphic calcareous, AM NCL – Automorphic non-calcareous, HM CAL – Hydromorphic calcareous, HM NCL – Hydromorphic non-calcareous.
[b] Soil layers: SC – soil cover, EP – epipedon, SS – subsoil.

Table 4. Different kinds of SOC functioning efficiency[a]

Kind of functioning	Debris and prehumus	Stabilized humus
Source of nutrition elements	+++	(+)
Source of energy for soil biota	+++	+
Initiating soil processes	+++	+
Regulation of soil exchangeable capacity	(+)	+++
Amelioration of soil physical properties	+	+++
Regulating self-purification capacity	++	++
Increasing soil water retention capacity	(+)	++

[a] Functioning efficiency: +++ – high, ++ – average, + – low, and (+) – very low.

Annual fluxes of SOC

Long-term periodical means of the annual fluxes of SOC input and output in equilibrated natural ecosystems formed in concordance with soil peculiarities are presented in Fig. 4. In most equilibrated ecosystems the annual input and output fluxes of SOC vary cyclically from year to year (Paustian et al., 1997; Körchens et al., 1998; Kleja et al., 2008). If on a long-term scale the SOC stocks of soil cover remain practically unchanged, then the periodical input and output balance should also be equal (input = output), or in actual circumstances no additional SOC sequestration nor SOC discharging should occur. Major differences in annual cycling levels exist between different soil types and regions (Chertov et al., 2002; West & Post, 2002; Sitaula et al., 2004).

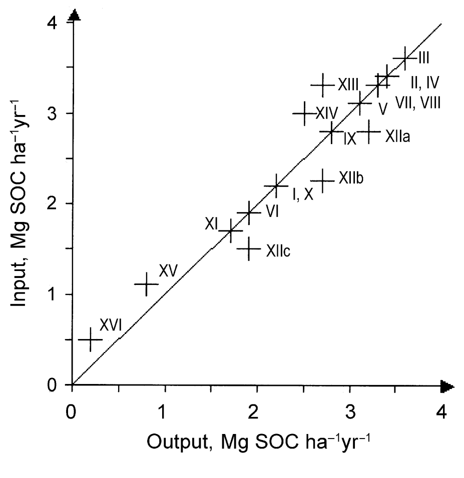

Fig. 4. Organic carbon annual circulation in natural conditions. Soil groups I–XVI, *see* Table 1. Soil group XII, which is developed on arable land under conventional agriculture, is divided by erosion stage into XIIa – weakly, XIIb – moderately, and XIIc – severely eroded subgroups.

In Estonia the annual SOC balance is highest (>3.5 Mg ha^{-1}) in high productivity forests formed on automorphic *Luvisols*, *Cambisols*, and *Albeluvisols*. In most cases the productivity and therefore the annual litter fall on hydromorphic soils is lower compared with their automorphic analogues. In Norwegian spruce ecosystems the annual input rates are in the range from 1.9 to 2.3 Mg C ha^{-1} yr^{-1} (Kleja et al., 2008). The lowest productivity and therefore lowest annual SOC cycling is characteristic of very young coastal soils (input and output <0.5 Mg ha^{-1}). A positive SOC balance (input > output) over a long-time scale is characteristic for deluvial and alluvial soils, but a negative one for soils influenced by erosion (input < output; Fig. 4).

During changes in land use the annual balance of SOC is transformed considerably (Yakimenko, 1998; Pulleman et al., 2000; Kurganova et al., 2007). Besides the hereditary soil fertility, the annual SOC balance depends much on the agro-technology used (i.e. crops and their rotation, level of subsidies, needs for soil amelioration). The SOC balance is clearly negative in the cultivation of potato and other inter-tilled crops (Fig. 5). Following good agricultural practice, the excessive annual expenses of SOC should be compensated with organic manure or with grown in situ green manure (phytomass). The annual output exceeds input also in the cultivation of cereals, and in case of higher yields the input into the soil is usually higher. For restoring SOC losses when growing cereals, perennial field grasses should be taken into crop rotation. On natural and semi-natural grasslands, the annual SOC in relation to soil cover tends to be positive, but the annual balances are lower compared with forest and arable lands. The only exceptions are alluvial soils and submerged delta soils. Of course, on arable lands with different subsidy levels of agro-technology (from low to high input) may be

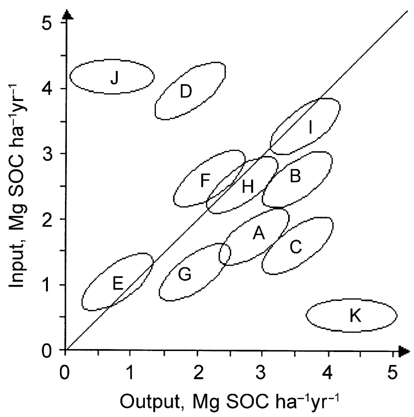

Fig. 5. Organic carbon annual circulation under various anthropogenic impacts. Cultivation of crops: A – barley, B – rye, C – potato, D – perennial grasses; semi-natural grasslands: E – dry and moist typical mineral grasslands, F – alluvial grasslands; kind of agro-technology: G – low input, H – sustainable, and I – high input agriculture; other impacts: J – application of organic manure at 45 Mg ha^{-1} and K – ploughed peaty soil without plant cover.

used. In cases of soil water stagnation (in gleysoils and especially in acidic peaty wet soils) the annual input decreases considerably.

The main purpose of ecologically sound management is to reach equilibrated cycling of substances which accords with soil cover capability and its main properties. The goal of sustainable SOC management is attaining the theoretically optimal SOC stock density for the soil type, using as a preliminary benchmark the mean weighted SOC-retaining capacity estimated according to the soil group.

The accumulation of SOC in soil in a stable form is a slow process. According to Kolchugina & Vinson (1998), the implementation of ecologically sound soil management practice results in an increase of SOC stocks in forest soils by 0.5% and in arable soils by 0.1% per year. With directed soil management, the annual SOC storage increase may be between 0.1 and 0.7 Mg SOC ha^{-1} (Paustian et al., 1997). The results of Romanovskaya (2006) show that the average loss of SOC from abandoned arable land reaches 0.46 Mg C ha^{-1} yr^{-1}, but an increase in SOC storage after a couple of years can be expected. Great SOC stock losses in the first years after a change from forest to arable land use are also reported by other researchers (Percival et al., 2000; Semenov et al., 2008). One of the possible reasons is the greater share of potentially mineralizable organic matter in forest soils. According to Semenov et al. (2008), the share of easily mineralizable organic matter in sod-podzolic forest and arable soils forms, respectively, 6.0% and 3.2% of total soil organic matter.

The turnover period of SOC in EP is much shorter than in SS and it is controllable (primarily on arable lands) with soil management. The main constraints (limiting SOC turnover and the level of productivity) of arable EP may be high acidity, low humus content, low biological activity, unsuitable mineral composition, the raw-humus fabric, and unfavourable moisture conditions. These constraints may be regulated by improving SOC management (e.g. by soil drainage, liming, equilibrated fertilization, and periodic inputs of fresh organic matter).

One way for embedding additional carbon into the soil is to increase soil productivity, which subsequently causes SOC stock increases in soil horizons (Rosell & Galantini, 1998; Halvorson et al., 2002). The optimization of soil humus status should be soil-type specific and arranged with a step-by-step approach to increase both soil productivity and the annual inflow of new organic matter into the soil. For ecologically-based soil management the identification of soil EP type is essential, as it reflects the intensity of SOC cycling (Kõlli et al., 2009).

Gleysols should be managed very carefully as there is a risk of losing a large part of SC SOC, which is weakly bound to the mineral soil particles. The reversion of low-fertility arable lands to forests may lead to additional sequestration of atmospheric CO_2 (Kurganova et al., 2007).

CONCLUSIONS

1. Organic carbon stocks in soil cover and its epipedon are soil-type specific. The weighted mean humus status indices of soil types may be used as

benchmarks in the arrangement of sustainable land use from the soil-based (pedocentric) perspective.

2. The aggregate of SOC retained in the mineral soils of Estonia (32 351 km^2) amounts to 323 ± 46 Tg. Of this (1) 42% is in stabilized humus, 40% in unstable raw humus material, and 18% in forest floor and shallow peats, and (2) 75% of it is situated in the biologically active epipedon and 25% in the subsoil.
3. The mean periodical annual inputs and outputs of soil organic carbon on natural soils vary from 0.2 to 3.6 Mg ha^{-1} yr^{-1} depending on the soil and ecosystem type. In the cultivation of natural soils the hereditary soil humus status and fertility may persist only in low input management conditions. The main goal of sustainable management of soil organic carbon on arable land is the attainment of the cycling of substances equilibrated with soil capability.

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Orgaanilise süsiniku varud ja aastavood Eesti mineraalmuldades

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Mulda siseneva ja sealt väljuva orgaanilise aine koosseisus oleva süsiniku alusel on analüüsitud 16 Eesti mineraalmullagrupi orgaanilise süsiniku (Corg) aastakäivet ning bilanssi. Muldade huumusseisundi ja produktiivsuse kvantitatiivsed näitajad pärinevad mullaprofiilide andmebaasist PEDON, mis koostati aastatel 1967–1985 ning mida täiendati aastatel 1986–1995 ja 1999–2005. Muldade jaotumuse aluseks mineraalmuldade (32 351 km^2) Corg koguvarude (323 ± 46 Tg) arvutamisel olid Eesti mullastiku suuremõõtkavalise kaardistamise andmed.

Mulla Corg varud, mis sõltuvad peamiselt mulla veerežiimist, savi ja karbonaatide sisaldusest ning kasutatavast agrotehnoloogiast, on töös esitatud epipedonite ja alusmuldade kohta. Suurima Corg akumuleerimisvõimega on turvastunud mullad. Seoses bioloogilise aktiivsuse seiskumusega alaliselt liigniisketes tingimustes on nende alusmuld aga Corg poolest vaene. Kuigi hüdromorfsete mittekarbonaatsete ja automorfsete karbonaatsete muldade Corg mahutusvõime on praktiliselt sarnased, on esimestel muldadel ligikaudu pool varust maetud muldkatte alumistesse kihtidesse ehk aktiivsest ringest eemaldatud. Automorfsete karbonaatsete muldade epipedon on aga rikas aineringes aktiivselt osaleva hea kvaliteediga Corg poolest.

Mulla orgaanilise aine aastakäive kajastab pikaajalise perioodi Corg keskmist aastakäivet ehk sisend- ja väljundvoogusid (Mg Corg ha^{-1} a^{-1}) ning bilanssi. Paljude aastate keskmised Corg sisend- ja väljundvood tasakaalustatud ökosüsteemide muldkattes varieeruvad piirides 0,2–3,6 Mg Corg ha^{-1} a^{-1}. Suurima Corg aastakäibega on automorfsed leetjad, rähksed, leostunud ja kahkjad mullad. Corg aastakäive on madal oma arengu algstaadiumis olevatel ranniku- ja tugevasti erodeeritud muldadel. Valdavalt on muldade Corg aastakäive looduslikes ökosüsteemides tasakaalustunud. Corg aastabilanss on negatiivne erodeeritud, kuid positiivne deluviaal- ja alluviaalmuldades.

Põllumuldade Corg bilanss on negatiivne teraviljade kasvatamisel. Eriti suur on mulla Corg aastakulu aga vaheltharitavate kultuuride kasvatamisel. Kogu külvikorra Corg bilanssi tasakaalustab põldheinte kasvatamine. Agroökosüsteemide Corg aastavoogude tase oleneb suuresti ka agrotehnilisest tasemest (ekstensiivne, tava-, intensiivne). Muldade ülesharimise ja liigniiskete alade kuivendamise toimel muutub mulla Corg bilanss negatiivseks ennekõike epipedoni piires. Muldade produktsioonivõime säilitamise hea põllumajandustava järgi peaks kulutatud Corg kompenseerima kas kohalkasvatatud või juurdetoodud Corg arvel.