

Assessment of soil organic carbon stocks in different land use in Lithuania

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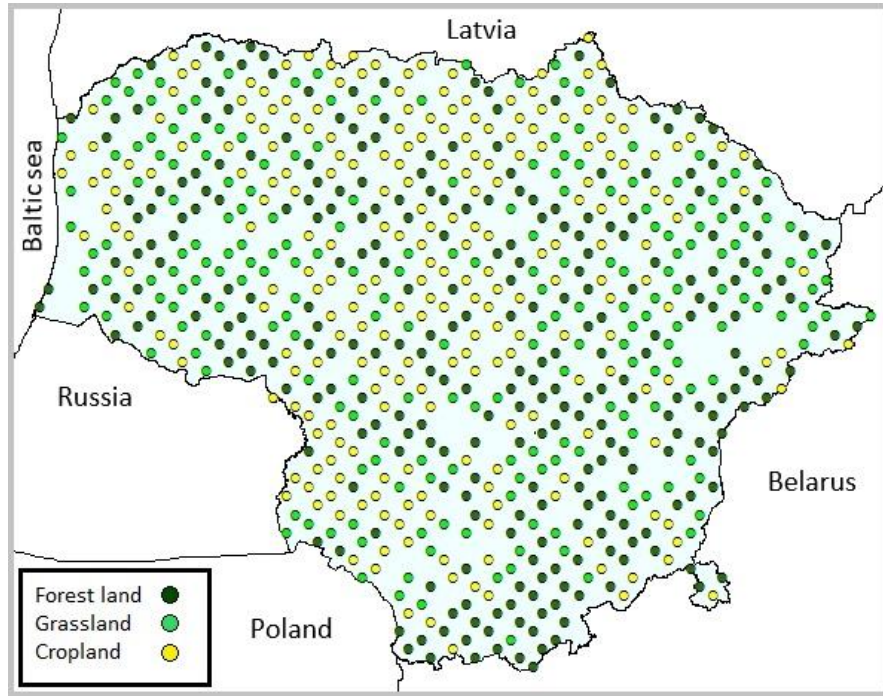
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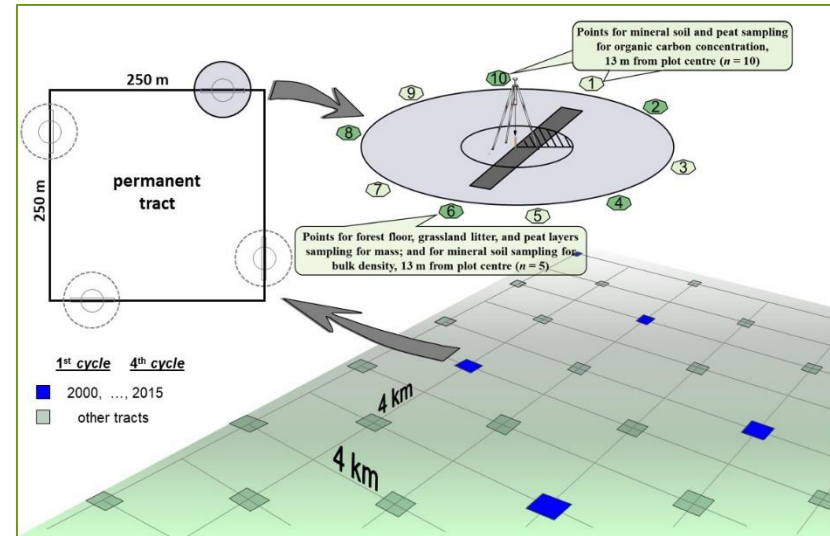
- Soil organic carbon (SOC) stocks at national level were estimated to provide more accurate estimates on SOC for the Lithuanian GHG inventory.
- **This study aimed to determine the SOC stocks in the forest floor, grassland litter, and in mineral or organic topsoil (0–30 cm) of forest land, grasslands, and croplands.**

- **Forests:** Lithuanian forests (33.5 % of the territory) belong to the hemiboreal forest zone with the prevalence of mixed deciduous and coniferous stands (Scots pine 35 %; Norway spruce 21 %, birch 22 %);
- **Croplands:** agricultural land covers ~50 % of Lithuania; wheat (65.5 %), barley (15.8 %), mixed grains and triticale (9.6 %), oats (5.0 %), rye (3.1 %), and corn (0.9 %);
- **Grasslands** cover about half of the agricultural land; represent non-degraded and sustainably managed grasslands.

Materials & Methods



Selected sample plots for soil sampling in the permanent plots grid (9×9 km) of Lithuanian National Forest Inventory (NFI) (2015; total $n = 754$; forest land $n = 288$; grassland $n = 218$; cropland $n = 248$)



The scheme of forest floor, grassland litter, mineral or peat topsoil sampling points outside the homogenous cycle permanent sample plot of NFI.

Materials & Methods

- Combined samples of **forest floor / grassland litter** ($n=5$) systematically were collected for the determination of **mass** and **carbon concentrations**.
- **Mineral / peat topsoil** combined samples (0-10 and 10-30 cm depth, $n=10$) were analysed for **bulk density** (ISO 11272:1998) and soil organic carbon (SOC) **concentrations** (ISO 10694:1995) (Cools, de Vos, 2016).
- Forest floor / grassland litter C stocks (SOC_i , tC ha^{-1}) were calculated by multiplying C concentrations with forest floor / grassland litter mass.
- The SOC stocks in 0-30 cm layer were calculated according the equation:

$$\text{SOC}_i = p_i \left(1 - \left(\frac{Q_{i,2mm}}{100} \right) \right) d_i C_i * 10^{-1}$$

where p_i is the bulk density of the <2 mm fraction in g cm^{-3} ; $Q_{i,2mm}$ is the relative volume of the fraction ≥ 2 mm (%); d_i denotes the thickness of layer i in cm; C_i denotes the C concentration of layer i (mg g^{-1}), and 10^{-1} is a unit factor ($10^{-9} \text{ mg Mg}^{-1} \times 10^8 \text{ cm}^2 \text{ ha}^{-1}$).

Results

Table 1. Distribution of major soil groups according the World Reference Base for Soil Resources in the sample plots representing different land uses

Major soil groups	All land uses		Forest land		Grassland		Cropland	
	%	n	%	n	%	n	%	n
Luvisols + Retisols	42.5	324	28.5	82	53.3	113	50.8	129
Arenosols	26.8	170	31.9	92	24.5	52	10.2	26
Cambisols	11.7	123	2.8	8	16.1	34	31.9	81
Planosols	6.0	42	9.1	26	3.3	7	3.5	9
Histosols	5.8	46	12.5	36	0.9	8	3.2	2
Gleysols	3.8	23	6.9	20	0.9	2	0.4	1
Podzols	2.9	22	7.3	21	0.5	1	-	-
Fluvisols	0.5	4	1.0	3	0.5	1	-	-
Total	100	754	100	288	100	218	100	248

Table 2. Mean mass of forest floor (OL+OF+OH) and plant litter in perennial grassland and mean organic carbon (OC) stocks in major soil groups

Major soil groups	Forest land			Perennial grassland		
	Number of plots	Mean mass (t ha ⁻¹)	Mean OC stocks (t ha ⁻¹)	Number of plots	Mean mass (t ha ⁻¹)	Mean OC stocks (t ha ⁻¹)
Cambisols	8	4.1±0.6	1.6±0.2	34	0.7±0.1	0.3±0.0
Luvisols + Retisols	82	13.6±3.5	5.6±1.5	113	1.6±0.2	0.6±0.1
Planosols	26	10.5±3.4	4.0±1.3	7	1.6±0.8	0.6±0.3
Arenosols	92	15.5±1.5	6.3±0.6	52	1.2±0.2	0.5±0.1
Podzols	21	59.8±16.6	25.7±7.2	1	0.2	0.1
Gleysols	20	15.0±7.1	6.6±3.3	2	3.2±0.7	1.3±0.3
Histosols	36	11.7±2.4	4.9±1.1	8	1.9±0.6	0.8±0.3
Fluvisols	3	2.3±1.0	0.9±0.4	1	1.4	0.5

Table 3. National Lithuanian values of soil organic carbon (SOC) stocks in 0–30 cm topsoil of major soil groups in forests, grassland and cropland

Major soil groups	Forests		Perrenial grassland		Cropland	
	n	SOC, t ha ⁻¹	n	SOC, t ha ⁻¹	n	SOC, t ha ⁻¹
Cambisols	8	118.0	34	83.2	81	84.5
Luvisols + Retisols	82	96.2	113	77.4	129	67.0
Planosols	26	76.6	7	94.7	9	61.4
Arenosols	92	55.7	52	55.3	26	62.0
Podzols	21	92.0	1	83.4	-	-
Gleysols	20	102.2	2	105.5	1	108.7
Histosols	36	150.5	8	181.5	2	243.2
Fluvisols	3	79.7	1	64.6	-	-

Table 4. Mean stocks (t ha⁻¹) of soil organic carbon (SOC) in 0-30 cm topsoil of major soil groups in forests


Major soil groups	LULUCF default values ^a (IPCC 2006)	SOC stocks in Europe (De Vos et al. 2015)	SOC stocks in Lithuania	
			Mean	<i>n</i>
Cambisol	95	71.4	118	8
Luvisols + Retisols	95	68.9/66.4	96	82
Planosols	-	51.5	77	26
Arenosols	71	40.9	56	92
Podzols	115	52.8	92	21
Gleysols	87	104.0	102	20
Histosols	-	186.0	150	36
Fluvisols	-	81.9	80	3

^aCold temperate, moist climate region (IPCC, 2006).

Main conclusions

- The total averaged SOC stock was 7.3 t ha⁻¹ in forest floor and 0.5 t ha⁻¹ in plant litter of perennial grasslands.
- In mineral forest soils, the averaged SOC stock varied from 56 t ha⁻¹ (Arenosols) to 118 t ha⁻¹ (Cambisols) and was 150 t ha⁻¹ (Histosols) in organic forest soils.
- The total averaged SOC stock in mineral topsoil was 80 t ha⁻¹ in forest land, 74 t ha⁻¹ in grassland, and 72 t ha⁻¹ in cropland.
- The findings of this study suggested that soil C stocks are more affected by soil type than by land use.

Evaluation of organic carbon stocks in mineral and organic soils in Lithuania

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Funding information

Ministry of Environment of the Republic of Lithuania in the frame of 2009-2014 European Economic Area or Norwegian Financial Mechanisms and Co-financing

Abstract

Soil organic carbon (SOC) stocks at national level were estimated to provide more accurate estimates on SOC for the Lithuanian GHG inventory. The SOC stocks in the forest floor, grassland litter, and in mineral or organic topsoil (0–30 cm) of forest land, grasslands, and croplands were estimated. The assessment was based on forest floor and peat topsoil mass, mineral topsoil bulk density, and carbon concentration in 754 permanent observation plots on 9 × 9 km grid of the National Forest Inventory in Lithuania. The SOC stocks were obtained for eight WRB Reference Soil Groups to provide the estimates for land use, land-use change, and forestry reporting. The SOC stocks in the forest floor, topsoil of mineral, and peat layers were identified for soils under different land uses. The mean SOC concentrations in the 0–10 and 10–30 cm topsoil of most soil groups, especially fertile forest soils (Cambisols, Luvisols +Retisols) were higher for forest land and grasslands, and lower for croplands. The total averaged SOC stock in the forest floor in mineral and organic soils was 6.97 t ha⁻¹, whereas in the litter of grasslands it was 0.54 t ha⁻¹. The averaged SOC stock in topsoil varied from 56 t ha⁻¹ (Arenosols) to 118 t ha⁻¹ (Cambisols) in mineral forest soils and was 150 t ha⁻¹ (Histosols) in organic forest soils. The total averaged SOC stock in mineral topsoil of forest land, grassland, and cropland was 80, 74, and 72 t ha⁻¹, respectively.

KEYWORDS

bulk density, different land use, forest floor, SOC concentration, SOC stock, soil group

Thank you!



The study was funded by Ministry of Environment of the Republic of Lithuania in the frame of 2009-2014 European Economic Area or Norwegian Financial Mechanisms and Co-financing.