Carbon budgets in a chronosequence of downy birch stands growing on drained swamp

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CONCLUSIONS:

- Young and middle-aged downy birch stands acted as C sink ecosystems.
- The over-matured downy birch downy birch stand acted as a C source
- Annual woody biomass increment of the stand was the main factor which affected the forest to act as a C accumulating system.
- Mean soil C emission did not differ significantly between the studied stands.
- The annual organic C input into the soil via above- and belowground litter was smaller than the annual R_h efflux
- The **soil C pool** was the main **C storage** and the C accumulated in the woody biomass of the trees accounted for only 5 – 20% of the total ecosystem's C pool.
- Concerning more effective C accumulation, **optimization of rotation length** for management of downy birch stands on drained organic soils could be an essential issue.

Drained forest - carbon sink or source?

BACKGROUND:

- A crucial issue is the quantification of the main output and input C fluxes in different forests and in the case of different management regimes.
- Forest management is closely related to C sequestration, while drainage may significantly affect stands C cycling.
- Moreover, the ratio of C accumulated in the soil to C accumulated into the biomass of trees is highlighted.
- Draining of moist soils in order to improve growth conditions for forests has been a common practice in northern regions.

Table 1. Carbon input and output fluxes and net ecosystem production (NEP) in the studied downy birch stands growing on well-drained peatlands

	Flux, t C ha^{-1} yr^{-1}	Stand age (yr.)				
		12	24	30	38	78
	Plant aboveground					
(1)	Leafless tree biomass increment	3.84	3.20	3.11	2.55	1.69
(2)	Leaf litter	1.63	1.50	1.65	1.62	1.17
(3)	Herbaceous understory production	0.14	0.19	0.17	0.10	0.05
	Plant belowground					
(4)	Coarse root biomass increment	0.79	0.63	0.71	0.47	0.27
(5)	Tree fine root production	0.89	1.07	1.19	1.48	0.92
(6)	Understory root and rhizome production	0.43	0.19	0.08	0.07	0.05
	Soil					
(7)	C output (Heterotrophic respiration)	4.7	5.1	5.5	6.2	5.1
(8)	C input = (2) + (3) + (5) + (6)	3.09	2.95	3.09	3.27	2.19
(9)	Soil C exchange = (8) - (7)	-1.61	-2.15	-2.41	-2.93	-2.91
	Productivity					
(10)	NPP = (1) + (2) + (3) + (4) + (5) + (6)	7.72	6.78	6.91	6.29	4.15
(11)	**NEP = (10) - (7)**	**3.02**	**1.68**	**1.41**	**0.09**	**-0.95**

STUDIED DOWNY BIRCH STANDS:

Table 2. The main characteristics of the downy birch stands; $D_{1.3}$ - average diameter at breast height, H – average height, BA - basal area, N - stand density. For $D_{1.3}$ and H standard errors are presented.

Age, yr	$D_{1.3}$, cm	H, m	BA, m^2 ha^{-1}	N, trees ha^{-1}
12	7.9±0.2	12.0±0.6	13.5	2,752
24	11.5±0.4	14.7±1.9	19.6	1,888
30	13.7±0.4	15.2±0.9	24.5	1,664
38	11.9±0.4	14.6±1.4	18.8	1,696
78	17.9±0.6	19.3±0.4	19.4	768

Table 3. Mean carbon concentration in different biomass fractions of downy birch stands. Letters indicated significant differences between fractions (t-test, $P<0.05$).

Fraction		C, %
Stemwood		47.00[a]
Stembark		51.02[b]
Branches (wood+bark)		48.60[a]
Twigs		51.56[b]
Fine roots	d<2 mm	49.12[a]
Coarse roots	d=2-5 mm	48.23[a]
	d=5-10 mm	47.80[a]
	d>10 mm	47.35[a]
Stump core		47.64[a]

LITERATURE: Uri, **V**., Kukumägi, M., Aosaar, J., Varik, M., Becker, H., Morozov, G., & Karoles, K. (2017). **Ecosystems carbon budgets of differently aged downy birch stands growing on well-drained peatlands.** *Forest Ecology and Management*, *399*, 82–93.

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