Supplementary Material

1. Field Sampling

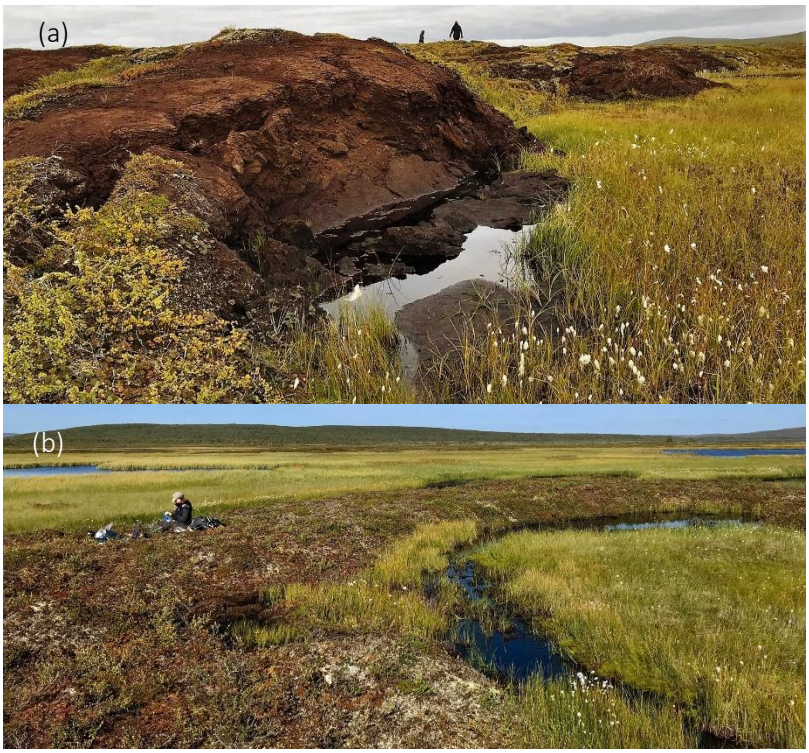


Figure S1. Field sampling at Dávvavuopmi: peat plateaus with signs of recent erosion (cracks in the surface, actively collapsing peat blocks into adjacent fens, submerged peat and open water) (a) and more gradual thaw, with less dramatic erosion and less pronounced height difference between landform types (b). Typical vegetation of peat plateaus includes dwarf shrubs (e.g. *Empetrum nigrum* ssp. *hermaphroditum*, *Betula nana), Rubus chamaemorus,* lichens, and mosses *(e.g. Polytrichum juniperinum, Dicranum elongatum)* (Kjellman et al., 2018; Sannel et al., 2018). Photos: C. Haugk.



Figure S2. Karlebotn with typical permafrost affected landforms: raised peat plateaus with sunken valleys with fens (a) as well as close-up of a peat plateau with surface cracks, a sign of active block erosion (b). Photos: C. Haugk.



Figure S3. Field sampling at a fen site at Šuoššjávri site (a) and an example of more rapid thaw processes from the field where peat blocks from peat plateaus are collapsing into adjacent fens (b). Photos: C. Haugk.



Figure S4. Field sampling at Lakselv site. Typical fen vegetation includes cotton grasses (*Eriophorum* spp.), sedges (*Carex* spp.), and mosses (*Sphagnum* spp.). Peat plateau visible in right corner, but height difference between landform types is less pronounced here. Photo: C. Haugk.

2. Figures

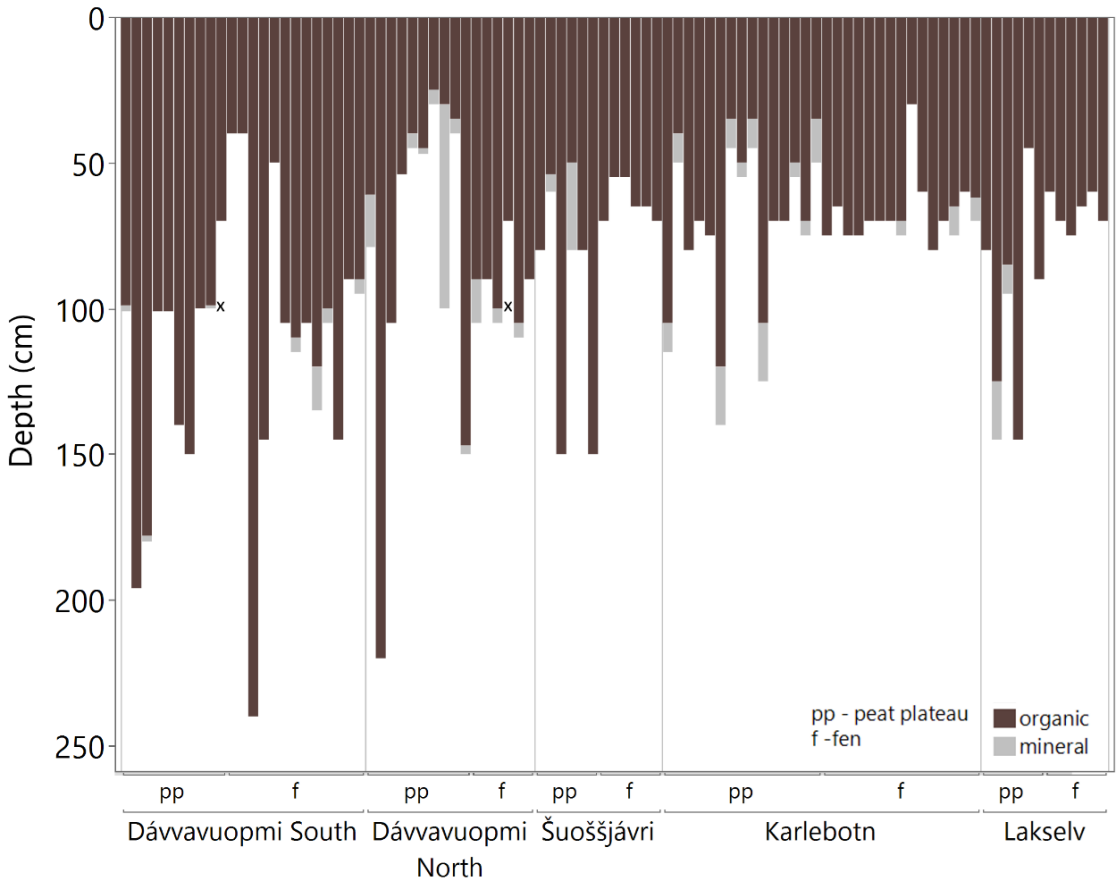


Figure S5. This dataset comprised 93 cores with 787 observations on mercury and 589 observations on carbon from five peatlands from Sweden and Norway (Dávvavuopmi South, Dávvavuopmi North, Šuoššjávri, Karlebotn and Lakselv). Here, the maximum length of all retrieved cores is shown in cm, with organic material (brown) on top of the mineral (grey), ordered by sites and landform types (pp-peat plateau, f-fen). We reached the mineral layer in a subset of 37 cores, (x - maximum depth of core at 70 cm, but max peat thickness 100cm, see Table S4).

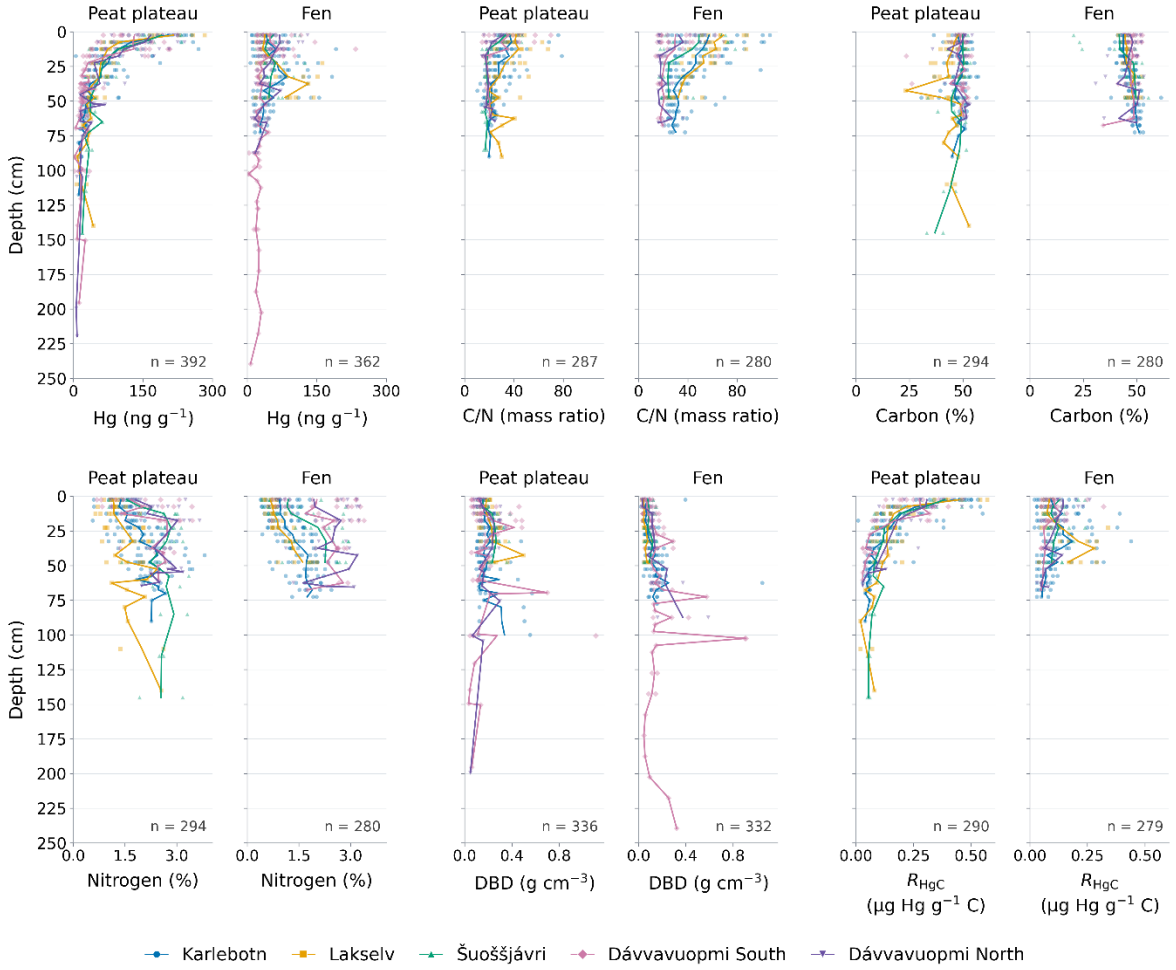


Figure S6. Depth profiles of mercury concentrations (ng Hg g^{-1}), carbon-to-nitrogen ratio (C/N), carbon concentration (C, %), nitrogen concentration (N, %), dry bulk density (DBD, g cm^{-3}), and Hg-to-carbon ratio ($R_{hg}C$) from peat plateaus and fens at five northern Scandinavian peatlands. Colours and symbols distinguish sites and lines connect arithmetic mean values for each site and landform at each sampled depth. Number of observation (n) in lower right corner of each panel.

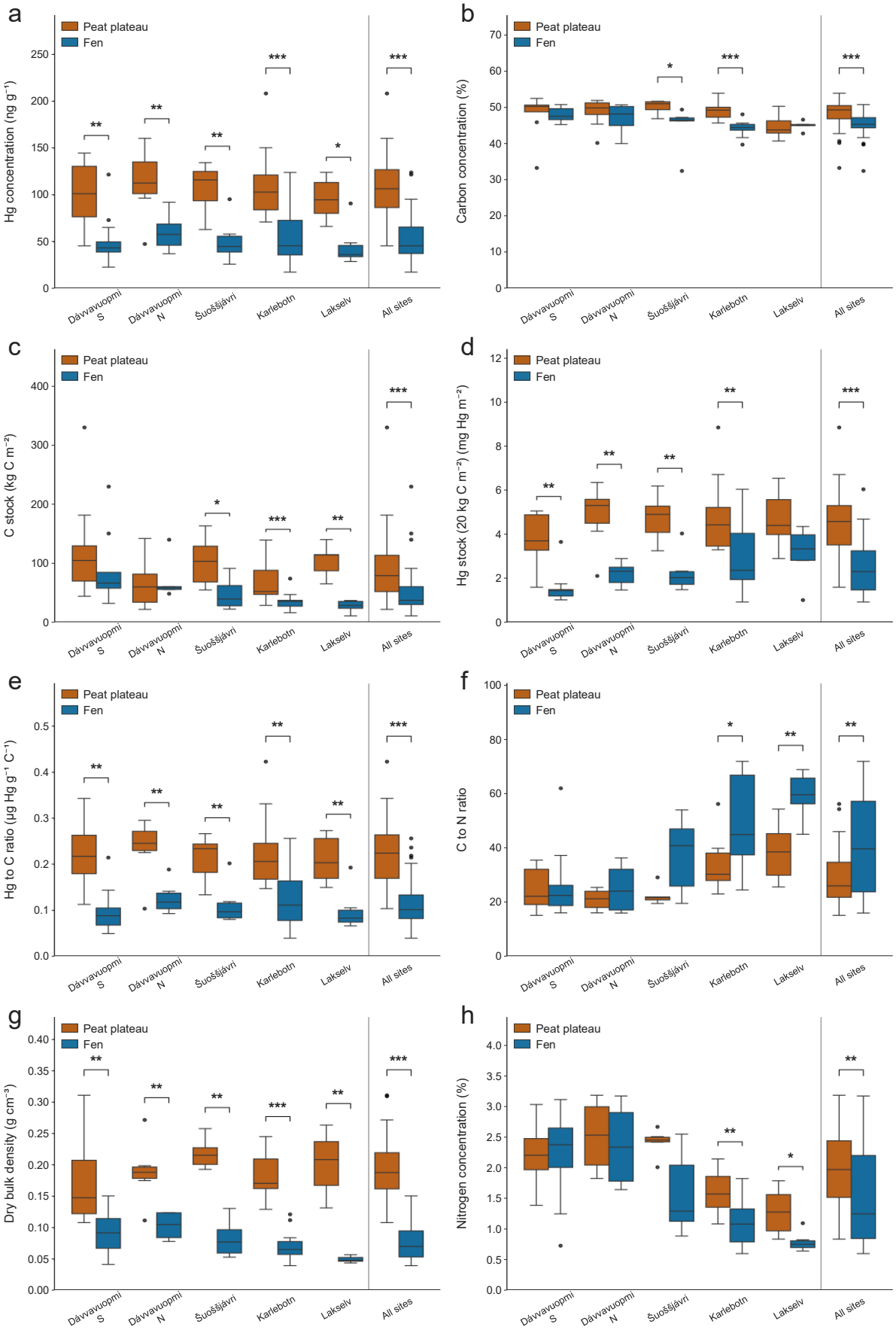

a
Peat plateau
Fen
Hg concentration (ng g⁻¹)
b
Carbon concentration (%)
c
C stock (kg C m⁻²)
d
Hg stock (20 kg C m⁻²) (mg Hg m⁻²)
e
Hg to C ratio (µg Hg g⁻¹ C⁻¹)
f
C to N ratio
g
Dry bulk density (g cm⁻³)
h
Nitrogen concentration (%)
Dávvavuopmi S
Dávvavuopmi N
Šuoššjávri
Karlebotn
Lakselv
All sites

Figure S7. Hg concentration (ng g-1) (a), carbon concentration (%) (b), C stock (kg C m-2) (c), Hg stock in upper 20 kg of carbon m-2 (mg Hg m-2) (d), RHgC (µg Hg g-1 C-1) (e), C/N ratio(f), dry bulk density (DBD, g cm-3) (g) for the upper 30 cm, and peat depths, used to integrate Hg stocks calculation in upper 20 kg C (h). Sites are ordered by latitude from south to north and compare landform types between peat plateau (orange) and fens (blue) with significance levels of $p<0.05$ (*) and $p<0.01$ (**) and $p<0.001$ (***) from comparison by Mann Whitney U test. Boxes represent the 25th and 75th percentiles, horizontal lines are the median, whiskers show interquartile range and points are outliers.

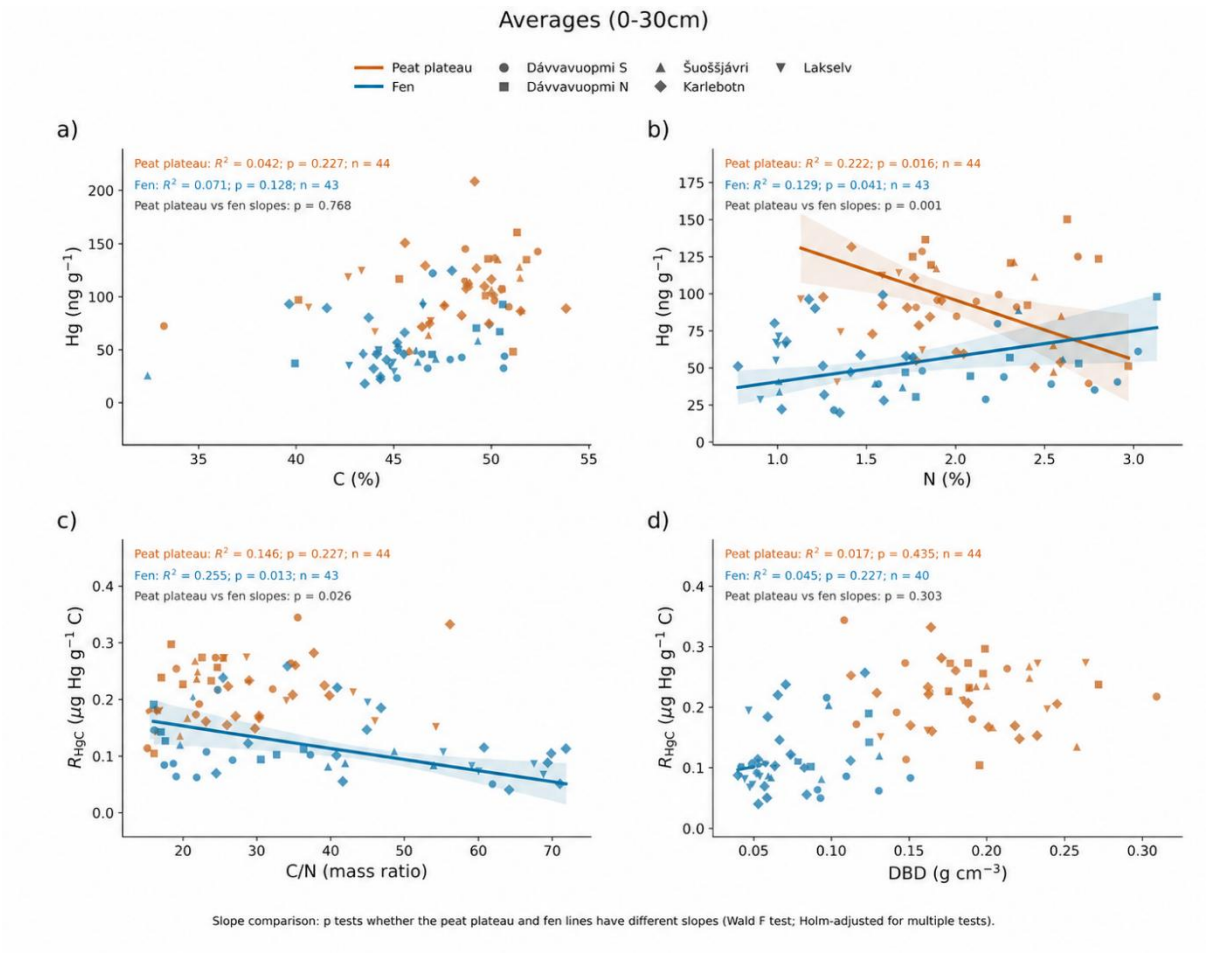


Figure S8. Relationships between averages for the upper 30 cm: (a) Hg and C concentrations, (b) Hg and N concentrations, (c) Hg to C ratio (R_{HgC}) and C/N, and (d) R_{HgC} and dry bulk density (DBD). Each point represents one core; colours distinguish peat plateaus (orange) and fens (blue), and marker shapes identify sites. Solid lines show site-adjusted linear regressions, with shaded areas indicating 95% confidence intervals. Annotations report R^2, p-values and sample size (n) for each landform slope as well as p-values comparing peat plateau and fen slopes using robust Wald F tests (Holm-adjusted).

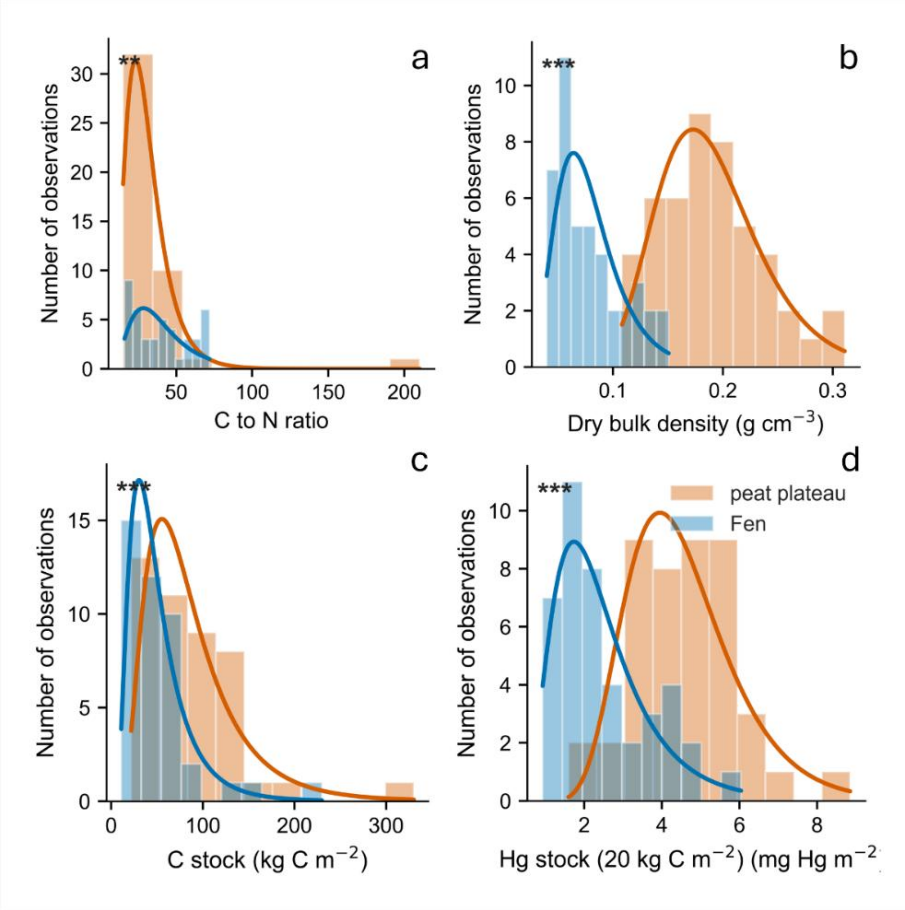


Figure S9. Distribution of mercury stock (Hg, mg Hg m^{-2}), carbon stock (C, kg C m^{-2}), Hg stock (20 kg C m^{-2}) (mg Hg m^{-2}) for the full peat profile, and distribution of C/N ratio datapoints in the upper 50 cm. Histograms are marked by landform type (peat plateau-orange, fen-blue). Significance levels are $p<0.01$ (**) and $p<0.001$ (***) for Mann-Whitney U test.

3. Tables

Table S1. Replicate measurements for Hg concentrations for each landform type for the four sites including standard deviation (SD) and relative standard deviation (RSD in %).

Site	Landform type	Mean Hg (ng g^{-1})	SD	RSD (%)
Dávvavuopmi	peat plateau	108.0	2.1	2%
Karlebotn	peat plateau	89.1	1.6	2%
Šuoššjávri	peat plateau	140.0	1.5	1%
Lakselv	peat plateau	110.7	1.3	1%
Dávvavuopmi	fen	121.9	1.2	1%
Karlebotn	fen	29.3	0.8	3%
Šuoššjávri	fen	28.8	3.3	12%
Lakselv	fen	22.1	0.2	1%

Table S2. Mean values, standard deviation and relative standard deviation reported for methionine and acetanilide quality assurance from the elemental analysis of peat samples.

	Methionine		Acetanilide	
	% N	% C	% N	% C
mean	9.2	41.0	10.1	70.5
SD	0.4	2.2	0.3	0.5
%RSD	5%	5%	3%	1%

Table S3. Replicate measurements of elemental analysis with corresponding standard deviation (SD) and relative standard deviation (RSD in %) for each landform type.

Landform type	Mean %N	SD	RSD (%)	Mean %C	SD	RSD (%)
peat plateau	2.0	0.1	5%	52.3	0.7	1%
fen	0.7	0.0	5%	44.3	0.01	0.02%

Table S4. Maximum depth (cm), start of permafrost sampling (cm), active layer thickness (cm) and peat thickness (cm) that were measured in the field for all 93 cores grouped by peatland and landform type.

Peatland	Landform type	Core ID	Max depth (cm)	Permafrost sampling starts at (cm)	Active layer thickness (cm)	Peat thickness (cm)
Dávvavuopmi North	fen	79	105			90
Dávvavuopmi North	fen	81	90			
Dávvavuopmi North	fen	83	105			100
Dávvavuopmi North	fen	84	70			100
Dávvavuopmi North	fen	85	110			105
Dávvavuopmi North	fen	90	90			
Dávvavuopmi North	peat plateau	78	79	61	64.5	61
Dávvavuopmi North	peat plateau	80	220	64	64.3	
Dávvavuopmi North	peat plateau	82	105	54	53.8	
Dávvavuopmi North	peat plateau	86	54			
Dávvavuopmi North	peat plateau	87	45		79.3	40
Dávvavuopmi North	peat plateau	88	47	46	56.7	46
Dávvavuopmi North	peat plateau	89	30		59.7	25
Dávvavuopmi North	peat plateau	91	100	99	88.3	30
Dávvavuopmi North	peat plateau	92	40			35
Dávvavuopmi North	peat plateau	93	149	55	57	148
Dávvavuopmi South	fen	56	40			
Dávvavuopmi South	fen	58	40		49.8	
Dávvavuopmi South	fen	60	240			
Dávvavuopmi South	fen	61	145			
Dávvavuopmi South	fen	63	50			
Dávvavuopmi South	fen	65	105			
Dávvavuopmi South	fen	66	115			110
Dávvavuopmi South	fen	67	105			

Dávvavuopmi South	fen	69	135			120
Dávvavuopmi South	fen	71	105			100
Dávvavuopmi South	fen	72	145			
Dávvavuopmi South	fen	74	90			
Dávvavuopmi South	fen	77	95			90
Dávvavuopmi South	peat plateau	55	101	44	60	100
Dávvavuopmi South	peat plateau	57	196	60	64.2	
Dávvavuopmi South	peat plateau	59	180	46	46	179
Dávvavuopmi South	peat plateau	62	101	50	58.3	
Dávvavuopmi South	peat plateau	64	101	40	40.8	
Dávvavuopmi South	peat plateau	68	140	43	42.7	
Dávvavuopmi South	peat plateau	70	150	55	57.8	
Dávvavuopmi South	peat plateau	73	100	41	43.3	
Dávvavuopmi South	peat plateau	75	100	50	54.5	99
Dávvavuopmi South	peat plateau	76	70	40	41	100
Karlebotn	fen	4	75			
Karlebotn	fen	5	65			
Karlebotn	fen	6	75			
Karlebotn	fen	10	75			
Karlebotn	fen	11	70			
Karlebotn	fen	12	70			
Karlebotn	fen	14	70			
Karlebotn	fen	16	75			70
Karlebotn	fen	18	30			
Karlebotn	fen	20	60			
Karlebotn	fen	22	80			
Karlebotn	fen	24	70			
Karlebotn	fen	26	75			65
Karlebotn	fen	28	60			
Karlebotn	fen	30	70			62
Karlebotn	peat plateau	1	115	50	52.4	105
Karlebotn	peat plateau	2	50			40
Karlebotn	peat plateau	3	80	70	67.6	
Karlebotn	peat plateau	7	70	60	61.8	
Karlebotn	peat plateau	8	75	65	55	
Karlebotn	peat plateau	9	140	60	57	120
Karlebotn	peat plateau	13	45		56.8	35
Karlebotn	peat plateau	15	55		90.2	50
Karlebotn	peat plateau	17	45			35
Karlebotn	peat plateau	19	125	55	58.8	105
Karlebotn	peat plateau	21	70		65	
Karlebotn	peat plateau	23	70	60	62.5	
Karlebotn	peat plateau	25	55		89.3	50
Karlebotn	peat plateau	27	75		120	70
Karlebotn	peat plateau	29	50			35
Lakselv	fen	31	60			
Lakselv	fen	32	70			
Lakselv	fen	33	75			
Lakselv	fen	34	65			
Lakselv	fen	35	60			
Lakselv	fen	36	70			
Lakselv	peat plateau	37	80			80
Lakselv	peat plateau	38	145	75	85.6	125
Lakselv	peat plateau	39	95	55	62.4	85
Lakselv	peat plateau	40	145	65	64.6	
Lakselv	peat plateau	41	45			
Lakselv	peat plateau	42	90	70	53.2	
Šuoššjávri	fen	43	70			
Šuoššjávri	fen	44	55			
Šuoššjávri	fen	45	55			
Šuoššjávri	fen	46	65			

Šuoššjávri	fen	47	65			
Šuoššjávri	fen	48	70			
Šuoššjávri	peat plateau	49	80	70	75.6	
Šuoššjávri	peat plateau	50	60	62	69.6	54
Šuoššjávri	peat plateau	51	150	60	63.8	
Šuoššjávri	peat plateau	52	80	60	62.4	50
Šuoššjávri	peat plateau	53	80	60	62.3	
Šuoššjávri	peat plateau	54	150	60	63.2	

Table S5. Summary statistics for peat plateau and fen for the upper 30 cm. Variables include mercury concentration, carbon concentration, dry bulk density, C/N, Hg to C ratio (R_{HgC}). Values are reported as range, median (Q1-Q3) or geometric mean (GMD; geometric standard deviation (GSD)). Superscript n indicates the number of cores included in each peatland and landform type.

Variable	Peat Plateau			Fen		
	Range[n]	**Median (Q1–Q3)**	**GMD (GSD)**	**Range[n]**	**Median (Q1–Q3)**	**GMD (GSD)**
[Hg] (ng g^{-1})	35.4–142.9[47]	75.8 (63.7–91.7)	75.6 (1.4)	20.3–113.9[46]	50.4 (37.2–68.9)	49.6 (1.5)
[C] (%)	20.7–52.3[44]	48.3 (43.5–50.3)	45.0 (1.2)	37.9–50.8[43]	46.6 (44.9–48.4)	46.1 (1.1)
DBD (g cm^{-3})	0.110–0.672[47]	0.202 (0.165–0.254)	0.210 (1.424)	0.040–0.173[45]	0.090 (0.060–0.104)	0.086 (1.439)
C/N	16–134[44]	24 (20–30)	25 (1)	16–61[43]	36 (22–47)	32 (2)
RHgC (µg Hg g^{-1} C^{-1})	0.08–0.58[44]	0.18 (0.14–0.21)	0.18 (1.47)	0.05–0.28[43]	0.11 (0.08–0.15)	0.11 (1.53)

Table S6. P-values are from two-sided Mann–Whitney U tests comparing peat plateau and fen for each site for mercury concentration (Hg, ng g^{-1}), carbon concentration (C, %), nitrogen (N, %), dry bulk density (DBD, g cm^{-3}), C/N ratio, mercury to carbon ratio (R_{HgC}, µg Hg g^{-1} C^{-1}) in 0-30 cm and 0-50 cm as well as mercury stocks (mg Hg m^{-2}) and carbon stocks (kg C m^{-2}) for the full peat profile.

Site	**[Hg] (0-30 cm)**	**[C] (0-30 cm)**	**[N] (0-30 cm)**	**DBD (0-30 cm)**	**C:N (0-30 cm)**	**RHg:C (0-30 cm)**
Dávvavuopmi S	0.003	0.236	0.967	0.003	0.967	0.001
Dávvavuopmi N	0.003	0.345	0.414	0.008	0.755	0.008
Šuoššjávri	0.009	0.015	0.065	0.002	0.180	0.009
Karlebotn	<0.001	<0.001	0.002	<0.001	0.011	0.002
Lakselv	0.015	0.589	0.015	0.002	0.009	0.009
	[Hg] (0-50 cm)	**[C] (0-50 cm)**	**[N] (0-50 cm)**	**DBD (0-50 cm)**	**C:N (0-50 cm)**	**RHg:C (0-50 cm)**
Dávvavuopmi S	0.012	0.111	0.838	0.003	0.775	0.003
Dávvavuopmi N	0.042	0.950	1.000	0.002	0.345	0.029
Šuoššjávri	0.041	0.485	0.132	0.002	0.240	0.015
Karlebotn	0.034	0.147	0.002	<0.001	<0.001	0.018
Lakselv	0.240	0.093	0.065	0.002	0.041	0.310
	Hg stock	**C stock**				
Dávvavuopmi S	0.032	0.017				
Dávvavuopmi N	0.147	0.020				
Šuoššjávri	0.026	0.310				
Karlebotn	0.002	0.011				
Lakselv	0.009	0.310				

Table S7. P-values are from Mann–Whitney U tests comparing landform types (peat plateau and fen) for mercury concentration (Hg, ng g^{-1}), carbon concentration (C, %), Dry bulk density (DBD, g cm^{-3}), C/N ratio, mercury to carbon ratio (R_{HgC}, µg Hg g^{-1} C^{-1}) in 0-30 cm and 0-50 cm as well as mercury stocks (mg Hg m^{-2}), carbon stocks (kg C m^{-2}) and Hg stock for the first 20 kg C m^{-2} for the full peat profile.

Variable	Mann–Whitney p-value
[Hg] (0-30 cm)	<0.001
[C] (0-30 cm)	<0.001
[N] (0-30 cm)	0.004
DBD (0-30 cm)	<0.001
C:N (0-30 cm)	0.006
RHg:C (0-30 cm)	<0.001
[Hg] (0-50 cm)	<0.001
[C] (0-50 cm)	0.28
[N] (0-30 cm)	0.04
DBD (0-50 cm)	<0.001
C:N (0-50 cm)	0.002
RHg:C (0-50 cm)	<0.001
Hg stock	<0.001
C stock	0.005
Hg stock (20 kg C m-2)	<0.001

Table S8. Adjusted p-values from Dunn's post hoc tests following Kruskal–Wallis tests comparing northern Scandinavian sites for peat plateaus and fens in the upper 30 cm. All fen samples include both internal and connected fens. * Indicates that the Kruskal–Wallis test was not significant ($p \geq 0.05$), and therefore no Dunn post-hoc comparison was performed.

Landform	Comparison	Hg	$R_{Hg:C}$	C	DBD	C:N	Hg stock	C stock	Hg stock (20 kg C)
Peat plateau	Dávvavuopmi N vs Dávvavuopmi S	*	*	*	*	1.000	1.000	0.484	*
	Dávvavuopmi N vs Karlebotn	*	*	*	*	<0.01	1.000	1.000	*
	Dávvavuopmi N vs Lakselv	*	*	*	*	<0.01	0.396	0.374	*
	Dávvavuopmi N vs Šuoššjávri	*	*	*	*	1.000	0.343	0.493	*
	Dávvavuopmi S vs Karlebotn	*	*	*	*	0.058	0.916	0.373	*
	Dávvavuopmi S vs Lakselv	*	*	*	*	0.060	0.165	1.000	*
	Dávvavuopmi S vs Šuoššjávri	*	*	*	*	1.000	0.133	1.000	*
	Karlebotn vs Lakselv	*	*	*	*	1.000	0.662	0.247	*
	Karlebotn vs Šuoššjávri	*	*	*	*	<0.05	0.618	0.431	*
	Lakselv vs Šuoššjávri	*	*	*	*	<0.05	1.000	1.000	*
Fen	Dávvavuopmi N vs Dávvavuopmi S	*	*	1.000	1.000	0.777	*	1.000	*
	Dávvavuopmi N vs Karlebotn	*	*	0.220	0.378	<0.05	*	0.068	*
	Dávvavuopmi N vs Lakselv	*	*	1.000	<0.05	<0.05	*	<0.05	*
	Dávvavuopmi N vs Šuoššjávri	*	*	1.000	1.000	0.770	*	0.756	*
	Dávvavuopmi S vs Karlebotn	*	*	<0.01	0.863	<0.05	*	<0.05	*
	Dávvavuopmi S vs Lakselv	*	*	0.205	<0.05	<0.01	*	<0.01	*
	Dávvavuopmi S vs Šuoššjávri	*	*	1.000	1.000	0.770	*	0.435	*
	Karlebotn vs Lakselv	*	*	1.000	0.290	0.770	*	1.000	*
	Karlebotn vs Šuoššjávri	*	*	0.426	1.000	0.770	*	1.000	*
	Lakselv vs Šuoššjávri	*	*	1.000	0.104	0.438	*	0.756	*

Table S9. Holm-adjusted p-values for pairwise comparisons of regression slopes among the five sites for the upper 30 cm, analysed separately for peat plateaus and fens with two-sided t test. To compare all five sites overall, regression slopes of all peat plateaus and fens were compared using a robust Wald F test. Hg–C, Hg–N and R_{HgC}–C/N uses 87 cores; R_{HgC}–DBD uses 86 cores.

Landform	Site comparison	Hg vs C	Hg vs N	R_HgC vs C/N	R_HgC vs DBD
	All sites	**0.545**	**0.838**	**0.028**	**0.545**
	Davva-S vs Davva-N	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-S vs Suossjavri	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-S vs Karlebotn	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-S vs Lakselv	**1.000**	**1.000**	**1.000**	**1.000**
Peat plateau	**Davva-N vs Suossjavri**	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-N vs Karlebotn	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-N vs Lakselv	**1.000**	**1.000**	**1.000**	**1.000**
	Suossjavri vs Karlebotn	**1.000**	**1.000**	**1.000**	**1.000**
	Suossjavri vs Lakselv	**1.000**	**1.000**	**1.000**	**1.000**
	Karlebotn vs Lakselv	**1.000**	**1.000**	**0.041**	**1.000**
	All sites	**0.328**	**1.000**	**1.000**	**1.000**
	Davva-S vs Davva-N	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-S vs Suossjavri	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-S vs Karlebotn	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-S vs Lakselv	**1.000**	**1.000**	**1.000**	**1.000**
Fen	**Davva-N vs Suossjavri**	**1.000**	**1.000**	**1.000**	**1.000**
	Davva-N vs Karlebotn	**0.963**	**1.000**	**1.000**	**1.000**
	Davva-N vs Lakselv	**1.000**	**1.000**	**1.000**	**1.000**
	Suossjavri vs Karlebotn	**1.000**	**1.000**	**1.000**	**1.000**
	Suossjavri vs Lakselv	**1.000**	**1.000**	**1.000**	**1.000**
	Karlebotn vs Lakselv	**1.000**	**1.000**	**1.000**	**1.000**

Table S10. Range, median (Q1-Q3) and geometric mean (GMD; geometric standard deviation (GSD)) for Hg stock calculated for the peat profile and Hg stock calculated for the upper peat with a carbon stock of 20 kg C m^{-2}. Superscript n indicates the number of cores included in each peatland and landform type.

Landform type	Site	Hg stock (mg Hg m^{-2})			Hg stock (20 kg C m^{-2}) (mg Hg m^{-2})		
		Range[n]	**Median (Q1–Q3)**	**GMD (GSD)**	**Range[n]**	**Median (Q1–Q3)**	**GMD (GSD)**
Peat plateau	Dávvavuopmi S	4.49-12.58[10]	6.86 (6.49–7.72)	7.11 (1.36)	1.60-5.05[9]	3.70 (3.28–4.88)	3.55 (1.44)
	Dávvavuopmi N	3.88-13.79[10]	7.96 (5.29–11.88)	7.61 (1.61)	2.11-6.35[8]	5.30 (4.50–5.58)	4.67 (1.41)
	Šuoššjávri	7.15-21.78[6]	13.13 (11.56–14.91)	12.90 (1.44)	3.25-6.19[6]	4.90 (4.09–5.28)	4.64 (1.26)
	Karlebotn	5.06-21.62[15]	7.88 (5.95–13.98)	9.07 (1.69)	3.29-8.85[15]	4.43 (3.46–5.22)	4.53 (1.33)
	Lakselv	5.80-23.64[6]	15.38 (11.17–18.92)	13.64 (1.66)	2.90-6.54[6]	4.40 (3.99–5.57)	4.51 (1.34)
Fen	Dávvavuopmi S	1.77-12.90[12]	4.32 (3.51–6.06)	4.50 (1.77)	1.02-3.65[9]	1.45 (1.20–1.49)	1.49 (1.45)
	Dávvavuopmi N	4.12-6.32[6]	5.00 (4.34–5.78)	5.03 (1.20)	1.47-2.90[6]	2.32 (1.81–2.50)	2.14 (1.30)
	Šuoššjávri	2.04-14.30[6]	3.42 (2.42–5.12)	4.00 (2.07)	1.49-4.04[6]	2.03 (1.73–2.30)	2.14 (1.42)
	Karlebotn	0.88-10.72[15]	3.85 (2.83–6.02)	3.85 (1.99)	0.93-6.04[15]	2.36 (1.95–4.04)	2.57 (1.76)
	Lakselv	1.15-9.30[6]	4.11 (2.31–6.97)	3.71 (2.24)	1.01-4.35[6]	3.34 (2.82–3.97)	2.86 (1.71)

4. References

Kjellman, S. E., Axelsson, P. E., Etzelmüller, B., Westermann, S., and Sannel, A. B. K.: Holocene development of subarctic permafrost peatlands in Finnmark, northern Norway, The Holocene, 28, 1855–1869, https://doi.org/10.1177/0959683618798126, 2018.

Sannel, A. B. K., Hempel, L., Kessler, A., and Préskienis, V.: Holocene development and permafrost history in sub-arctic peatlands in Tavvavuoma, northern Sweden, Boreas, 47, 454–468, https://doi.org/10.1111/bor.12276, 2018.

Tarbier, B., Hugelius, G., Sannel, A. B. K., Baptista-Salazar, C., and Jonsson, S.: Permafrost Thaw Increases Methylmercury Formation in Subarctic Fennoscandia, Environ. Sci. Technol., 55, 6710–6717, https://doi.org/10.1021/acs.est.0c04108, 2021.