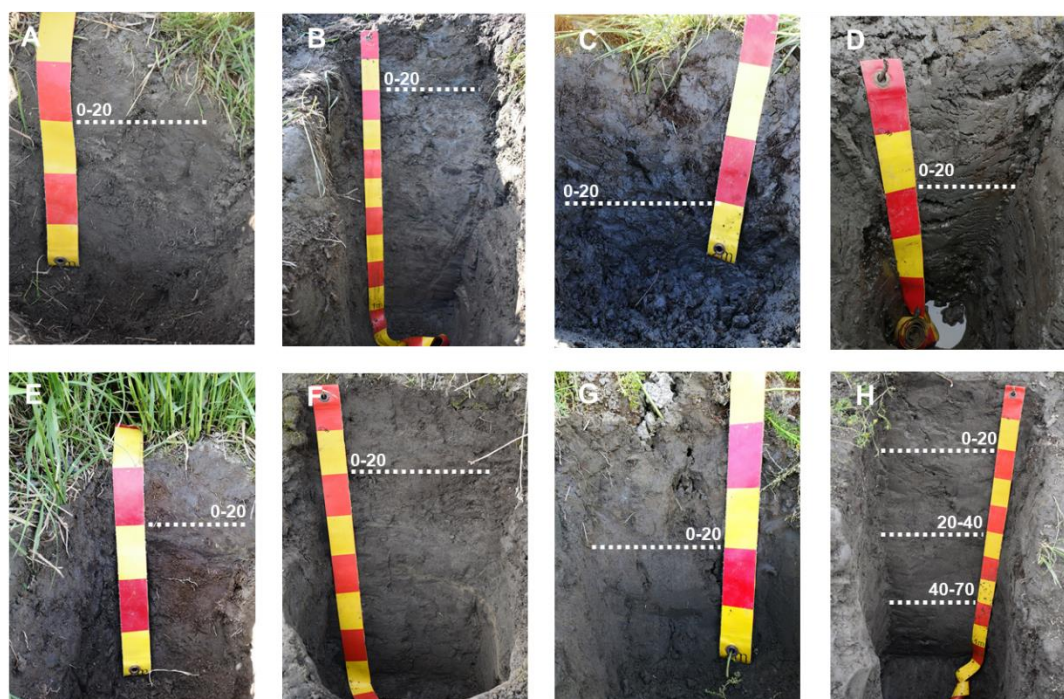


# Supplementary Material



**Figure S1.** Studied field sites in 2019. (A): Revegetated slump floor SF3 V, (B): non-vegetated slump floor SF3 NV, (C): revegetated slump floor SF6 V, (D): non-vegetated slump floor SF6 NV, (E): revegetated thaw mound TM1 V, (F): non-vegetated thaw mound TM1 NV, (G): revegetated thaw mound TM2 V, (H): non-vegetated thaw mound TM2 NV. All vegetated sites are mainly covered by grasses and herbs and only SF6 NV is covered only by mosses.





**Figure S2.** Soil profiles with indication of analyzed depths (composite samples) of studied field sites in 2019. All soils were described as Protic Cryosols [26] (A): revegetated slump floor SF3 V, (B): non-vegetated slump floor SF3 NV, (C): revegetated slump floor SF6 V, (D): non-vegetated slump floor SF6 NV, (E): revegetated thaw mound TM1 V, (F): non-vegetated thaw mound TM1 NV, (G): revegetated thaw mound TM2 V, (H): non-vegetated thaw mound TM2 NV.

**Table S1.** Coordinates of the sampled soil profiles in July 2019. Samples were taken from revegetated (V) and non-vegetated (NV) slump floor (SF) and thaw mounds (TM) soils.

Site	Position
SF3 V	72.3390 N 126.2921 E
SF3 NV	
SF6 V	72.3390 N 126.2914 E
SF6 NV	
TM1 V	72.3393 N 126.2929 E
TM1 NV	
TM2 V	72.3393 N 126.2919 E
TM2 NV	

**Table S2.** Subsoil samples from the non-vegetated thaw mound site TM2 NV. Soil properties (water content (WC), water-filled pore space (WFPS), soil pH (pH), total carbon (TC), water extractable organic carbon (WEOC), carbon nitrogen ratio (C/N), phosphorus (P), delta  $^{15}\text{N}$  in bulk soil ( $\delta^{15}\text{N}$ ), dissolved organic nitrogen (DON), ammonium ( $\text{NH}_4^+$ ), nitrate ( $\text{NO}_3^-$ )), nitrogen transformation, as well as anaerobic GHG production rates and  $\text{CO}_2$  equivalents ( $\text{CO}_2\text{eq}$ ) are given for composite samples from 20–40 cm and 40–70 cm depth ( $n$  = number of replicates).

Paramter	TM2 NV 20–40 cm	TM2 NV 40–70 cm
$n$	3	3
WC (%)	$17 \pm 0$	$16 \pm 0$
WFPS (%)	n.d.	$43 \pm 0$
pH	$8.1 \pm 0$	$8.2 \pm 0$

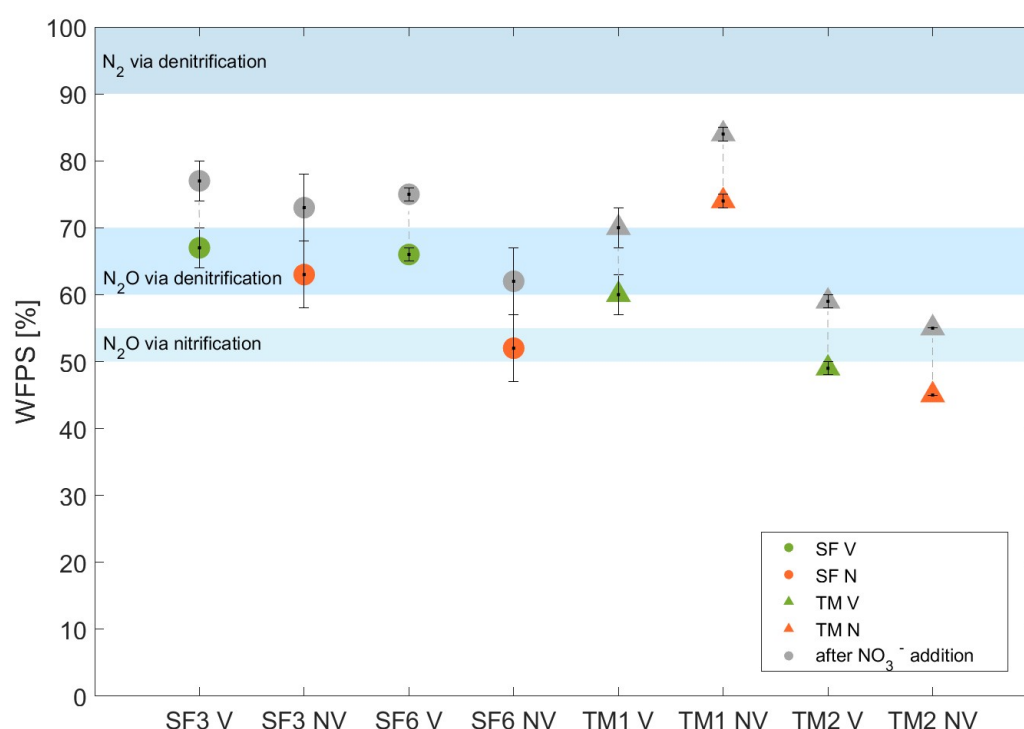
TC (%)	2.1 ± 0.0	1.6 ± 0.0
WEOC (µg C (g DW) <sup>-1</sup> )	n.d.	83*
C/N	13.7 ± 0.1	13.8 ± 0.4
P (µg P (g DW) <sup>-1</sup> )	8.5 ± 0.4	8.2 ± 0.0
δ <sup>15</sup> N bulk (‰)	2.73 ± 0.04	2.75 ± 0.02
DON (µg N (g DW) <sup>-1</sup> )	17.09 ± 1.32	b.d.l
NH <sub>4</sub> <sup>+</sup> (µg N (g DW) <sup>-1</sup> )	4.99 ± 0.10	3.47 ± 0.08
NO <sub>3</sub> <sup>-</sup> (µg N (g DW) <sup>-1</sup> )	9.75 ± 0.23	5.23 ± 0.44
Net ammonification (ng N (g DW) <sup>-1</sup> d <sup>-1</sup> )	0.00 ± 0.00	5.47 ± 2.51
Net nitrification (ng N (g DW) <sup>-1</sup> d <sup>-1</sup> )	1044.02 ± 50.44	866.78 ± 14.48
N <sub>2</sub> O ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup>	63.66 ± 6.54	22.17 ± 10.48
N <sub>2</sub> O with Nitrate (ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup> )	25.05 ± 11.06	29.73 ± 6.16
CO <sub>2</sub> (µg CO <sub>2</sub> -C (g DW) <sup>-1</sup> d <sup>-1</sup> )	0.68 ± 0.08	0.82 ± 0.07
CH <sub>4</sub> (ng CH <sub>4</sub> -C (g DW) <sup>-1</sup> d <sup>-1</sup> )	0.00 ± 0.00	0.00 ± 0.00
CO <sub>2</sub> eq (µg CO <sub>2</sub> eq-C (g DW) <sup>-1</sup> d <sup>-1</sup> )	19.65 ± 2.03	7.43 ± 3.19

Values (mean ± standard deviation), \* *n* = 1. n.d. = not determined. b.d.l. = below the detection limit.

**Table S3.** Dissolved nitrogen components for revegetated (V) and non-vegetated (NV) slump floor (SF) and thaw mound (TM) soils (*n* = number of replicates).

Site	<i>n</i>	DON (µg N (g DW) <sup>-1</sup> d <sup>-1</sup> )	NH <sub>4</sub> <sup>+</sup> (µg N (g DW) <sup>-1</sup> d <sup>-1</sup> )	NO <sub>3</sub> <sup>-</sup> (µg N (g DW) <sup>-1</sup> d <sup>-1</sup> )
SF3 V	3	b.d.l.	0.06 ± 0.09	0.55 ± 0.78
SF3 NV	3	19.05 ± 4.22	6.31 ± 2.36	31.23 ± 6.20
SF6 V	5	37.30 ± 5.42*	16.73 ± 2.66	0.53 ± 0.59
SF6 NV	2	37.54 ± 8.39	14.67 ± 1.16	0.73 ± 0.04
TM1 V	3	9.30 ± 4.49	0.00 ± 0.00	81.64 ± 24.37
TM1 NV	3	4.17 ± 5.90	0.16 ± 0.20	7.05 ± 6.26
TM2 V	3	b.d.l.	0.00 ± 0.00	11.05 ± 1.16
TM2 NV	3	3.06 ± 4.32	1.34 ± 0.45	9.44 ± 1.61

Values (mean ± standard deviation), \* *n* = 4. b.d.l. = below the detection limit.



**Figure S3.** Water-filled pore space (WFPS) for revegetated (green) and non-vegetated (orange) sites. With substrate addition (152 mM nitrate) the WFPS increased about 10% (grey). Blue bars indicate the optimal WFPS for N<sub>2</sub>O release via nitrification (50–55%), denitrification (60–70%), as well N<sub>2</sub> loss via denitrification (>90%) according to Voigt et al. [7].

**Table S4.** N<sub>2</sub>O production rates from the anaerobic incubation (4 °C) without and with nitrate addition (152 mM) for revegetated (V) and non-vegetated (N) slump floor (SF) and thaw mound (TM) soils (*n* = number of replicates).

Site	<i>n</i>	N <sub>2</sub> O (ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup> )	N <sub>2</sub> O with Nitrate (ng N <sub>2</sub> O-N (g DW) <sup>-1</sup> d <sup>-1</sup> )
SF3 V	3	0.00 ± 0.00	2277.65 ± 1374.37
SF3 NV	3	95.43 ± 43.21	63.04 ± 30.14
SF6 V	5	0.00 ± 0.00	3,312.74 ± 426.27
SF6 NV	2	0.10 ± 0.10	1827.23 ± 1307.69
TM1 V	3	216.63 ± 158.25	91.78 ± 107.96
TM1 NV	3	0.00 ± 0.00	40.14 ± 49.89
TM2 V	3	27.85 ± 27.75	16.33 ± 1.05
TM2 NV	3	25.16 ± 1.30	22.66 ± 6.05

Values (mean ± standard deviation).

**Table S5.** CO<sub>2</sub> equivalents (CO<sub>2</sub>eq) calculated from the anaerobic incubation without and with nitrate addition (152 mM) for revegetated (V) and non-vegetated (N) slump floor (SF) and thaw mound (TM) soils (*n* = number of replicates).

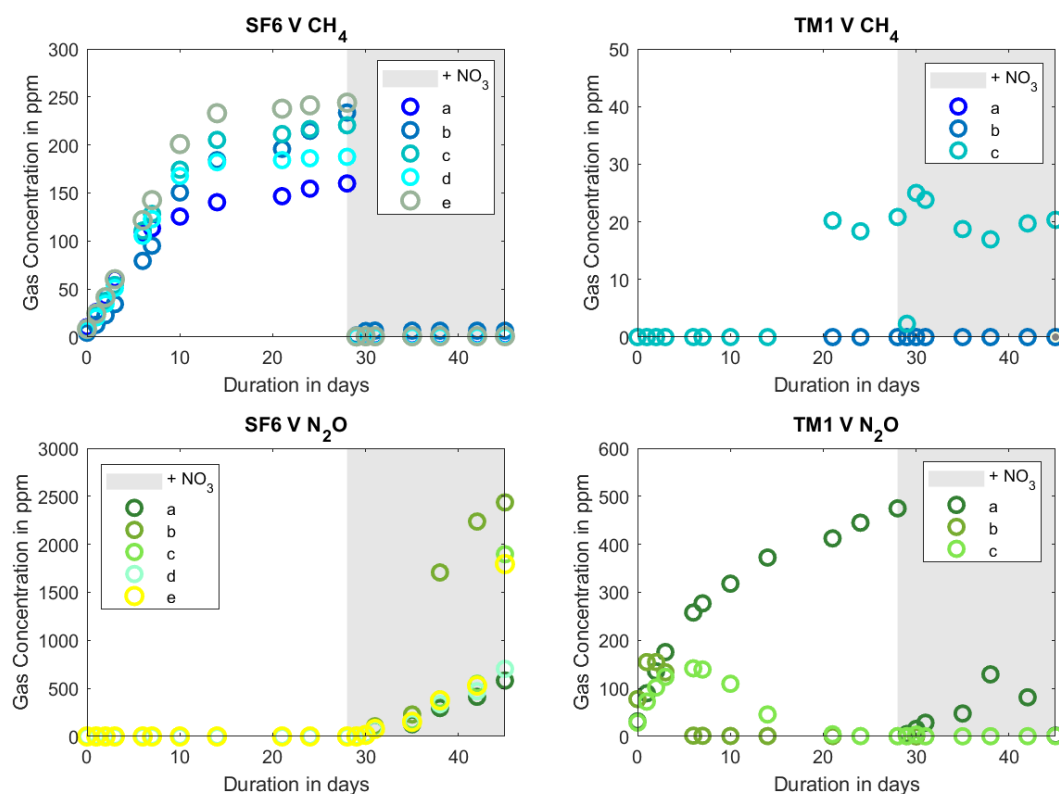
Site	<i>n</i>	CO <sub>2</sub> eq (μg CO <sub>2</sub> eq-C (g DW) <sup>-1</sup> d <sup>-1</sup> )	CO <sub>2</sub> eq with Nitrate (μg CO <sub>2</sub> eq-C (g DW) <sup>-1</sup> d <sup>-1</sup> )
SF3 V	3	6.51 ± 3.00	681.78 ± 410.59
SF3 NV	3	29.43 ± 13.20	19.56 ± 9.24
SF6 V	5	9.29 ± 1.73	990.09 ± 127.85
SF6 NV	2	3.27 ± 1.72	546.97 ± 389.94
TM1 V	3	65.71 ± 47.03	29.11 ± 31.60

TM1 NV	3	2.56 ± 0.88	15.66 ± 16.03
TM2 V	3	8.56 ± 8.26	5.03 ± 0.32
TM2 NV	3	8.02 ± 0.27	7.42 ± 2.02

Values (mean ± standard deviation).

**Table S6.** Dates of *in-situ* N<sub>2</sub>O measurements in 2019. Measurements were made only at non-vegetated (NV) slump floor (SF) and thaw mound (TM) sites. *In-situ* N<sub>2</sub>O fluxes are given in Table 4.

Site	Date of Measurements
SF3 V	n.d.
SF3 N	10, 18, 23-07-2019
SF6 V	n.d.
SF6 N	10, 19, 23-07-2019
TM1 V	n.d.
TM1 N	10, 23-07-2019
TM2 V	n.d.
TM2 N	11, 17, 18, 23-07-2019



**Figure S4.** Cumulative CH<sub>4</sub> (above) and N<sub>2</sub>O (below) headspace gas concentration for the selective sites SF6 V (left) and TM1 V. The gray space indicates the period where the flasks were flushed with N<sub>2</sub> and subsequently nitrate was added. Left: Samples produced directly at the beginning CH<sub>4</sub> till flasks were flushed and N<sub>2</sub>O production started. Right: There was no CH<sub>4</sub> production but in replicate c, CH<sub>4</sub> production started after N<sub>2</sub>O concentration declined in the headspace.