LIFE PeatCarbon

Greenhouse gas emissions from near-natural, rewetted and degraded mires

Team of Latvian State Forest Research institute "Silava" researchers

Materials and Methods

The study was conducted across seven sites established in four mires (Figure 1). Each site contained three plots representing specific habitats, grouped into three categories: near-natural, rewetted, and degraded mires (Table 1). Monthly measurements of soil CO_2, CH_4, and N_2O efflux were performed from June 2023 to October 2025. Annual CH_4 and N_2O fluxes were calculated by summing monthly mean effluxes, while CO_2 efflux was annualised by interpolation using plot-specific continuous soil temperature data and temperature–CO_2 response relationships.

Annual soil carbon (C) balance was quantified using a mass-balance approach: annualised CO_2-C efflux was combined with soil C inputs from tree fine litterfall, moss, herbaceous vegetation, and shrubs. Net greenhouse (GHG) emissions in CO_2 equivalents are expressed by applying 100-year GWP (AR5). Assumptions: moss annual increment equals annual mortality; belowground biomass turnover rate = 0.33; shrub aboveground turnover rate = 0.25 by (Muukkonen, 2006); and the fraction of litter C entering soil was set to 1.0 for belowground litter and 0.8 for aboveground litter (Bragazza et. al., 2009).

Figure 1: Locations of the study sites in Latvia

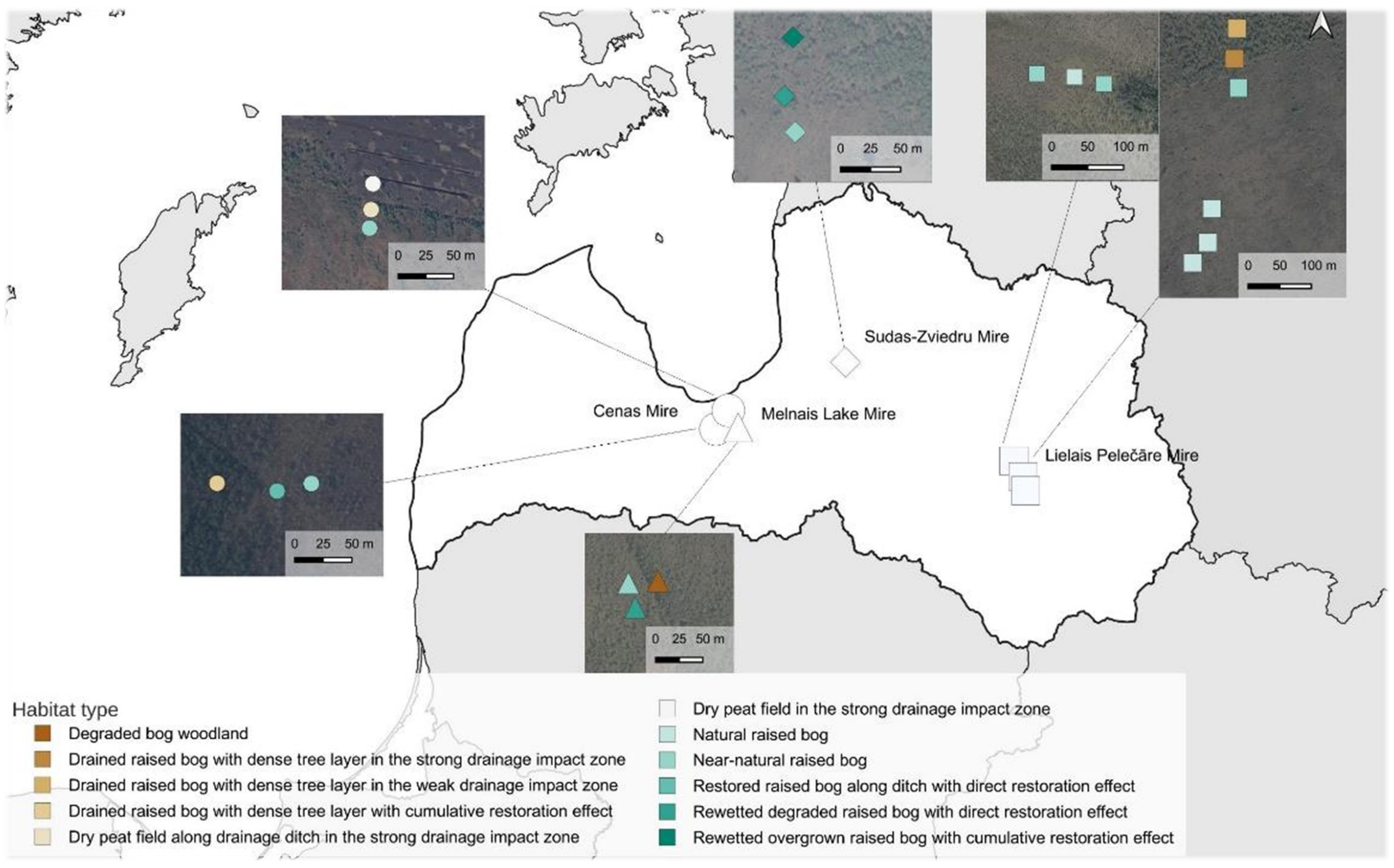
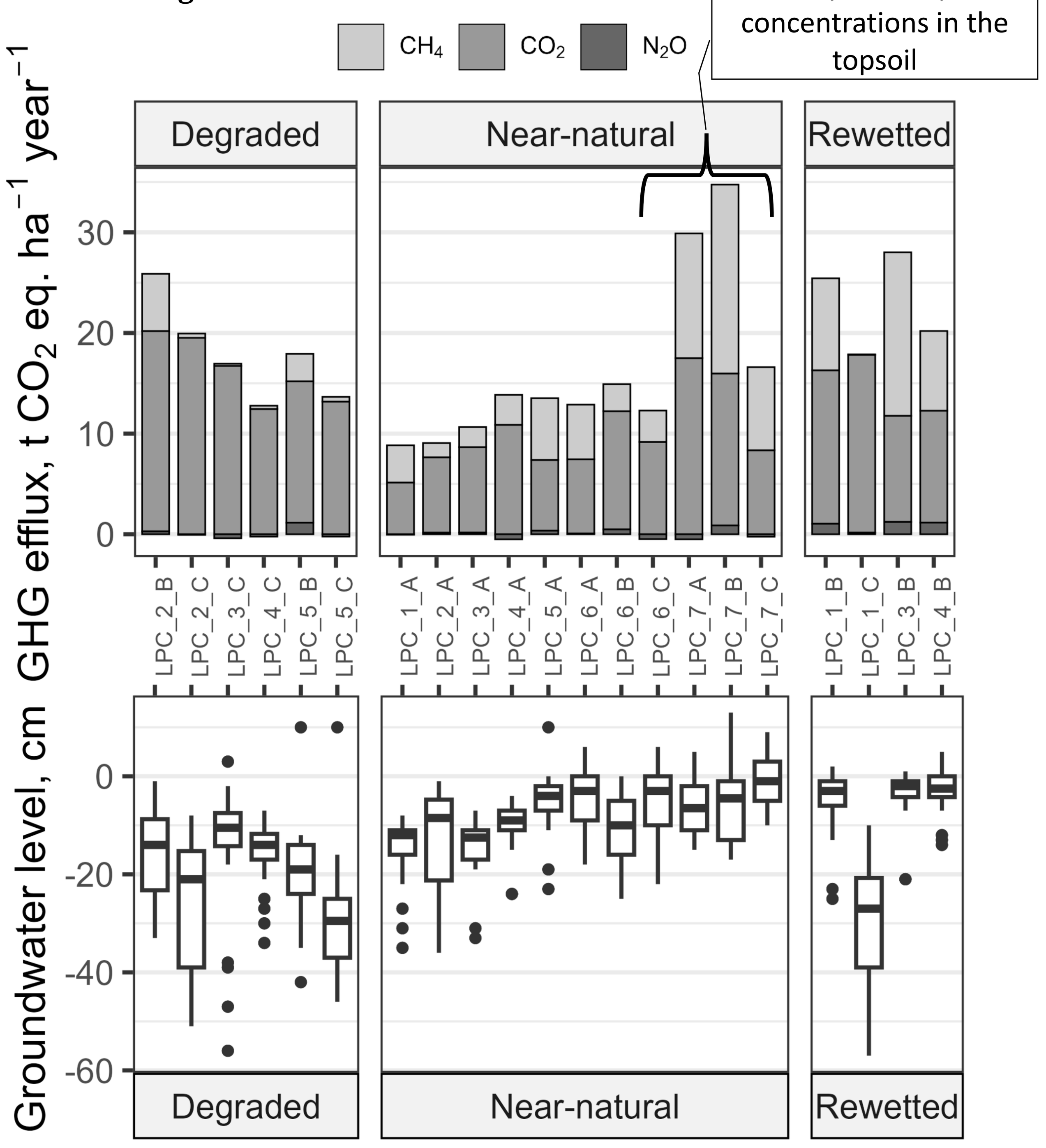


Table 1: Description of the study sites

Mire	Site	Plot	Category	Habitat
Sudas-Zviedru	LPC_1	A	Near-natural	Near-natural RB
	LPC_1	B	Rewetted	Rewetted degraded RB with direct RE
	LPC_1	C	Rewetted	Rewetted overgrown RB with cumulative RE
Lielais Pelečāre	LPC_2	A	Near-natural	Near-natural RB
	LPC_2	B	Degraded	Drained RB with dense tree layer in the strong DIZ
	LPC_2	C	Degraded	Drained RB with dense tree layer in the weak DIZ
Melnais Lake	LPC_3	A	Near-natural	Near-natural RB
	LPC_3	B	Rewetted	Rewetted degraded RB with direct RE
	LPC_3	C	Degraded	Degraded bog woodland
Cenas	LPC_4	A	Near-natural	Near-natural RB
	LPC_4	B	Rewetted	Restored RB along ditch with direct RE
	LPC_4	C	Degraded	Drained RB with dense tree layer with cumulative RE
	LPC_5	A	Near-natural	Near-natural RB
	LPC_5	B	Degraded	Peat field along drainage ditch in the strong DIZ
	LPC_5	C	Degraded	Dry peat field in the strong DIZ
Lielais Pelečāre	LPC_6	A	Near-natural	Natural RB
	LPC_6	B	Near-natural	Natural RB
	LPC_6	C	Near-natural	Natural RB
	LPC_7	A	Near-natural	Near-natural RB
	LPC_7	B	Near-natural	Natural RB
	LPC_7	C	Near-natural	Near-natural RB

RB – raised bog
DIZ – drainage impact zone
RE – restoration effect

Figure 2: Soil greenhouse gas efflux and groundwater level



Results

Annualised soil CO_2 efflux, C inputs, and consequently estimated soil C balance did not differ significantly between habitat categories due to high flux variability (Figures 2 and 3). However, mean values indicated that degraded soils were close to C flux equilibrium, suggesting stable soil C stocks, while near-natural and rewetted soils showed uncertain C sequestration potential (Figure 4). When CH_4 and N_2O emissions are considered, all habitat types acted as net GHG sources. Near-natural habitats were nearly GHG neutral on average. Degraded habitats showed slightly higher emissions, while rewetted habitats exhibited the highest GHG emissions.

These patterns could largely be associated with water table dynamics. In most degraded subplots, the water table was variable, but generally averaged around 20 cm below the surface, limiting organic matter decomposition while simultaneously creating conditions conducive to CH_4 emissions. Near-natural sites with water table levels generally between 0 and 20 cm below the surface showed potential for soil C removals sufficient to offset CH_4 emissions. In contrast, despite relatively stable raised groundwater levels, rewetted sites exhibited the highest GHG emissions due to elevated CH_4 and N_2O fluxes, probably reflecting recent disturbance effects. One rewetted plot, distinct from the others due to a developed tree stand, showed no increase in N_2O and CH_4 emissions, as water table observations indicated that rewetting had not resulted in a consistently elevated water table.

Overall, the results suggest that both near-natural and rewetted sites show potential for preserving or increasing peatland carbon stocks. However, when CH_4 emissions are included in the GHG balance, rewetting in our sites did not result in net GHG emission reductions. Near-natural plots generally showed lower CH_4 emissions despite elevated groundwater levels. At the same time, observed outliers in near-natural plots indicate that substantially increased CH_4 emissions may occur not only following rewetting but can also persist as long-term emission hotspots.

Figure 3: Annual soil CO_2-C efflux and influx (Rsoil – soil respiration, Rtot – soil and ground vegetation respiration)

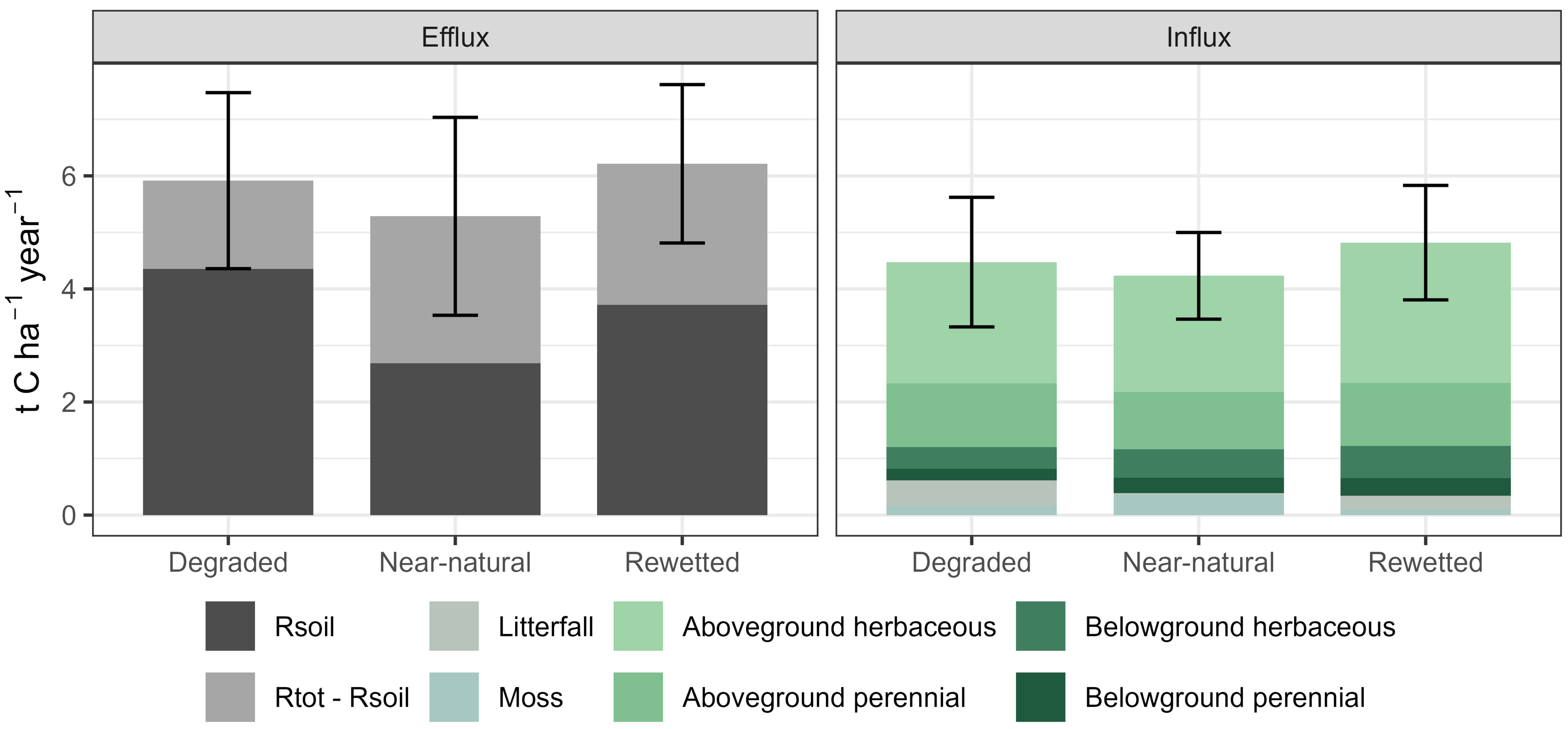
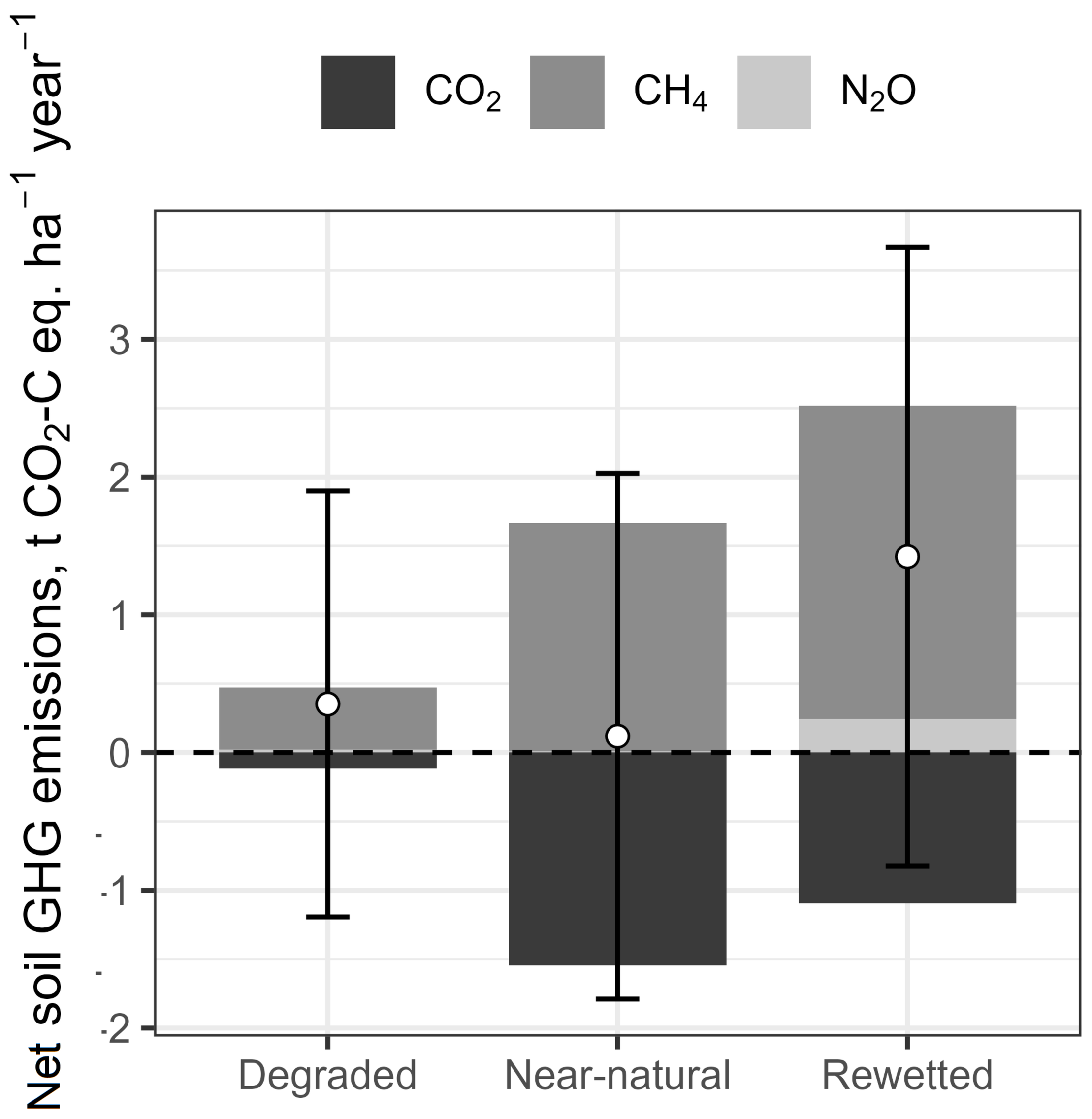


Figure 4: Net soil GHG emissions



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www.peatcarbon.lu.lv

Contacts: Ph.D. Aldis Butlers, e-mail: aldis.butlers@silava.lv