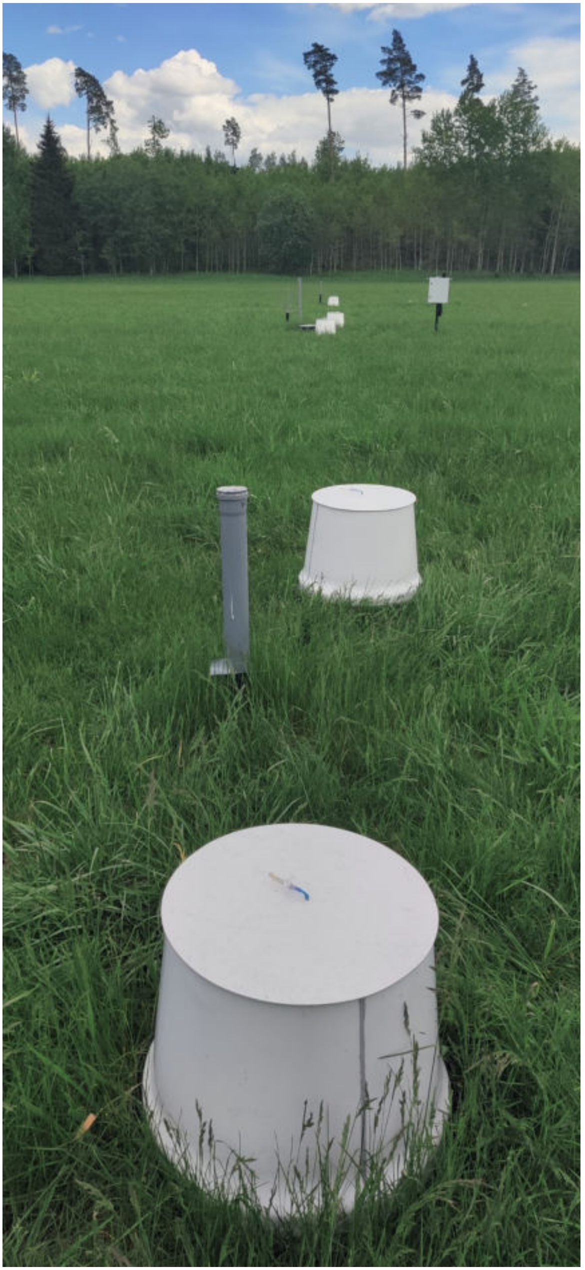

Drainage Impact on Greenhouse Gas Emissions from Grasslands and Croplands on Nutrient-rich Organic Soils in Baltic Countries

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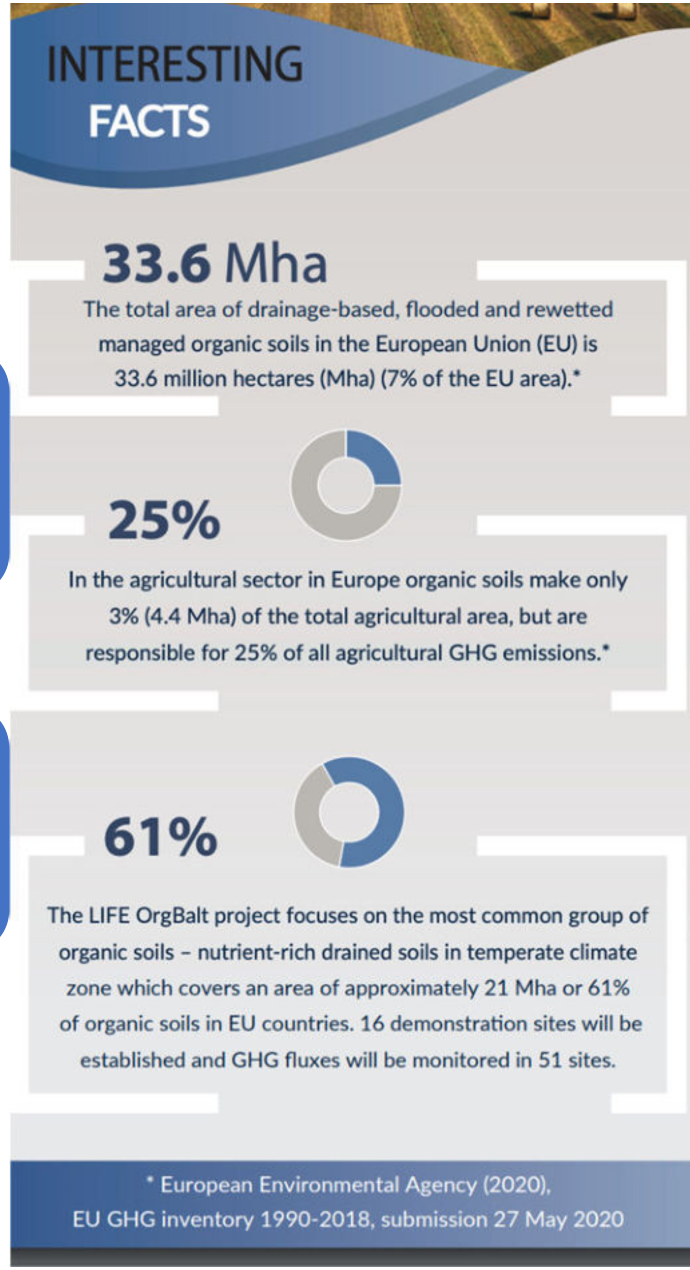
Why to study?

Organic soils – one of the largest terrestrial carbon stores, mainly in boreal, temperate and tropical wet climate zones

- These environments are deficient in oxygen; therefore, organic matter decomposes slowly and accumulates

Drained nutrient-rich organic soils – one of the largest key sources of GHG emissions in the LULUCF sectors in Boreal and Temperate cool and moist climate regions in Europe

- Increased carbon dioxide (CO_2) and nitrous oxide (N_2O) emissions due to increased soil mineralization and reduced methane (CH_4) emissions compared to natural wetlands where no soil drainage and tillage are done

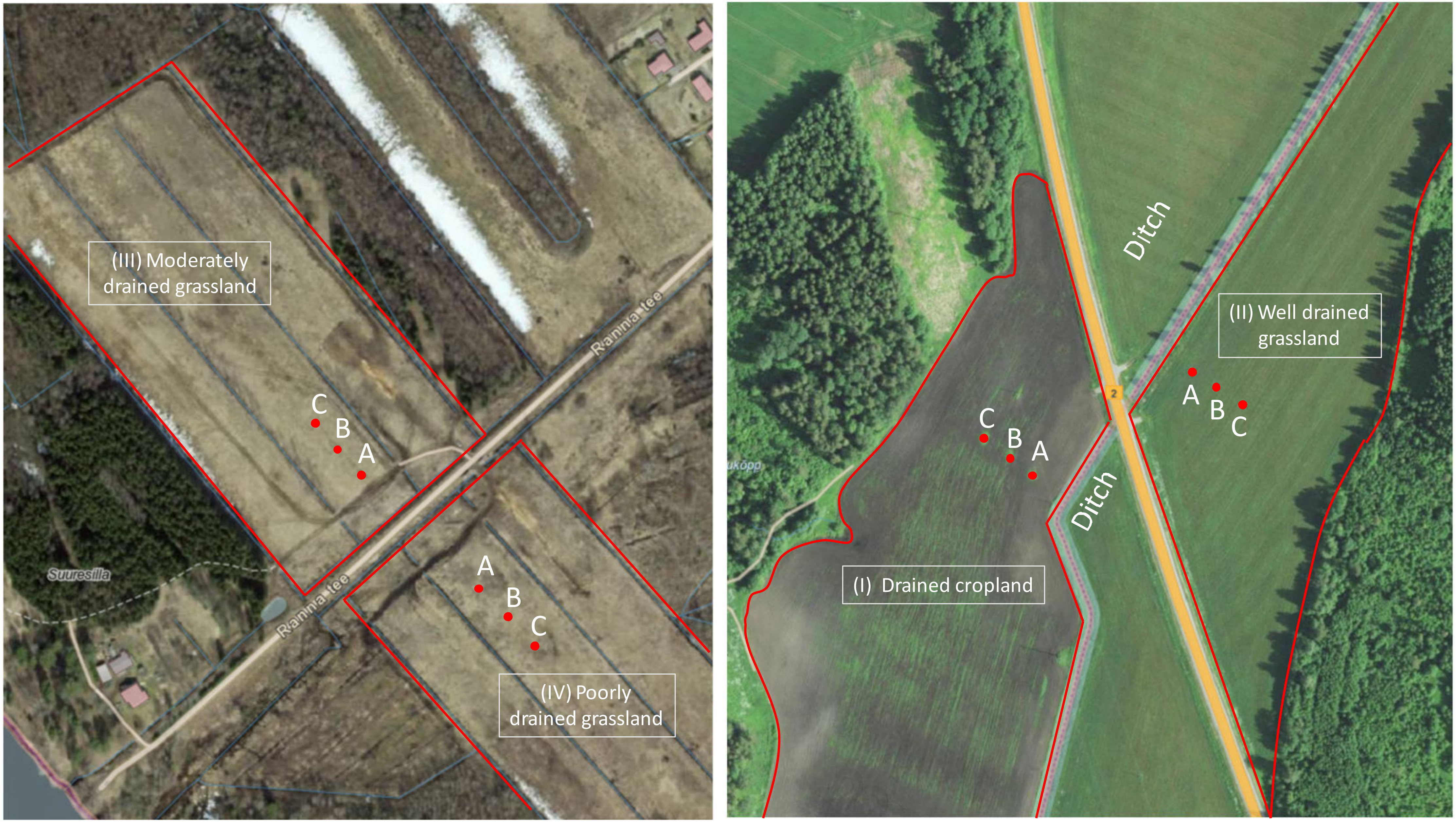


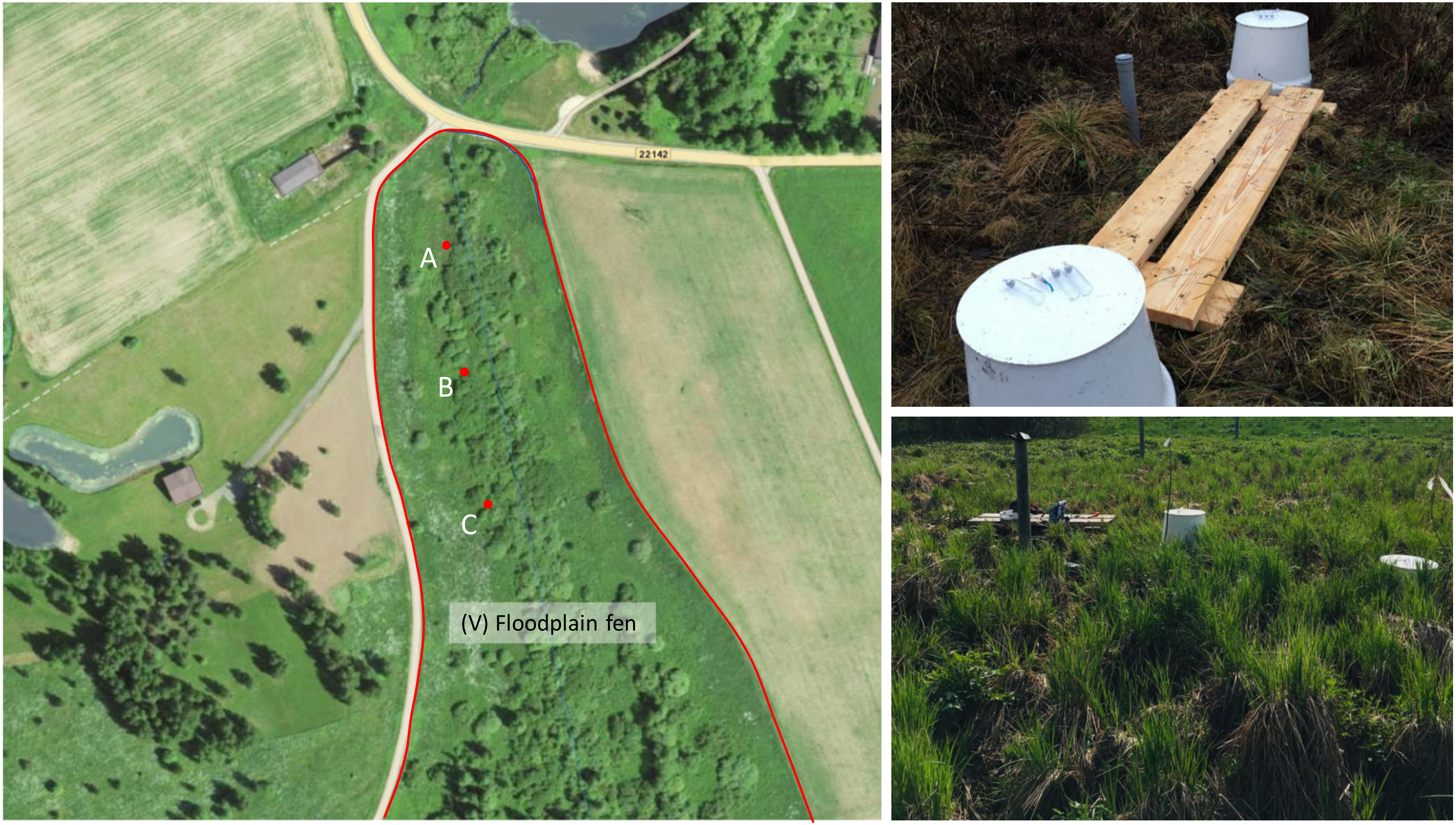
Material and methods – sites & steps

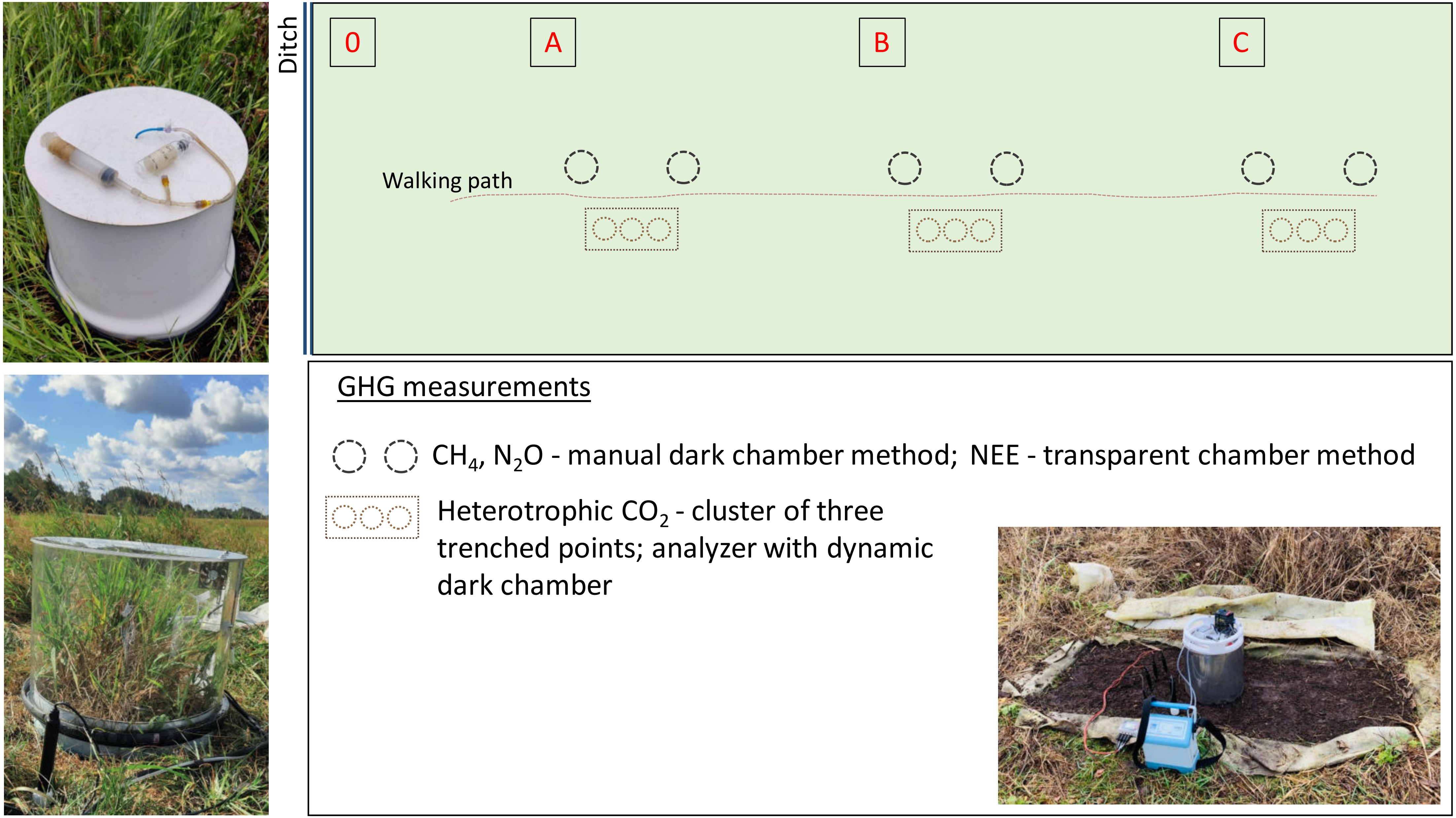
Study period: Jan. 2021–Dec. 2022

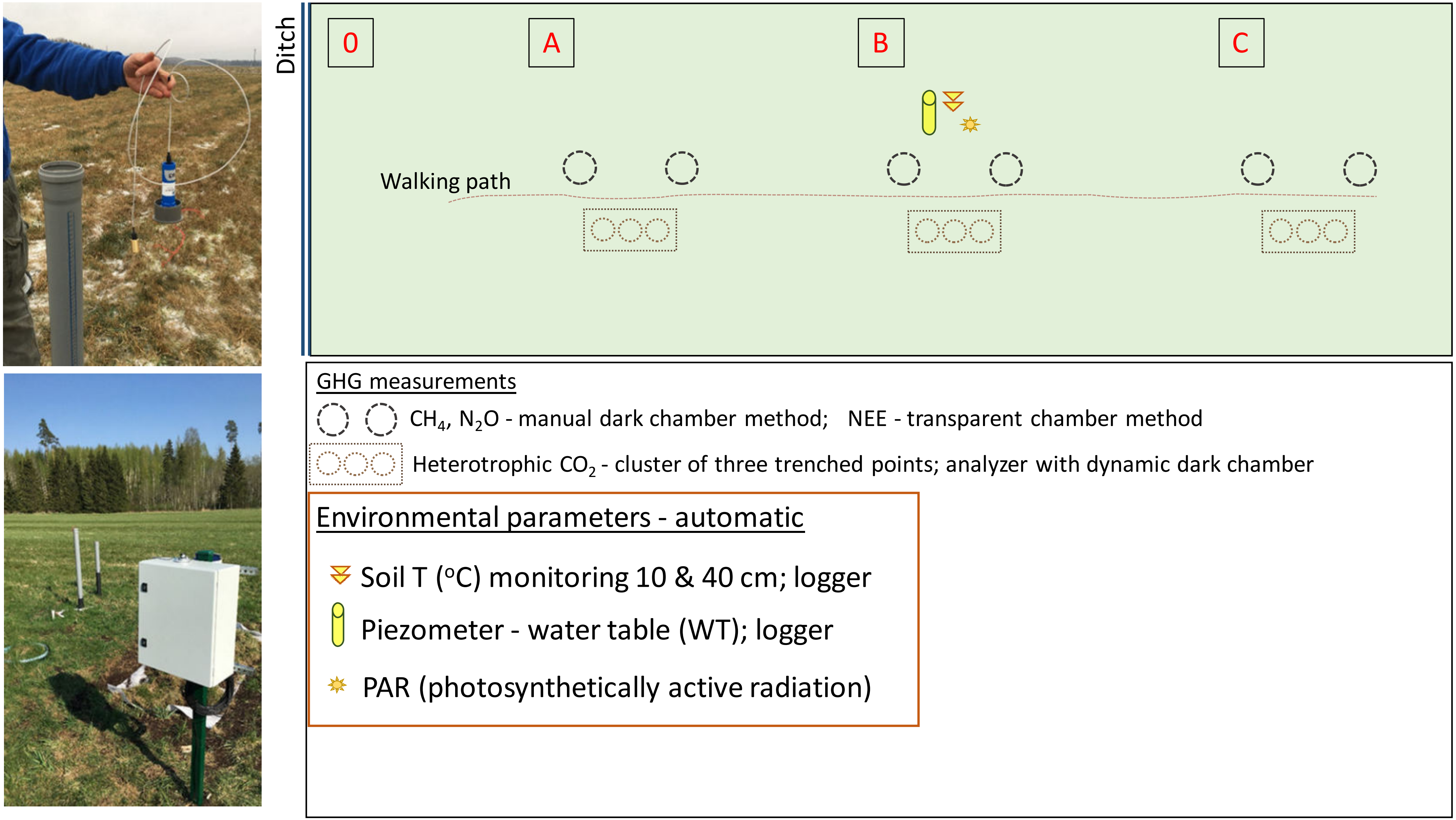
Sites

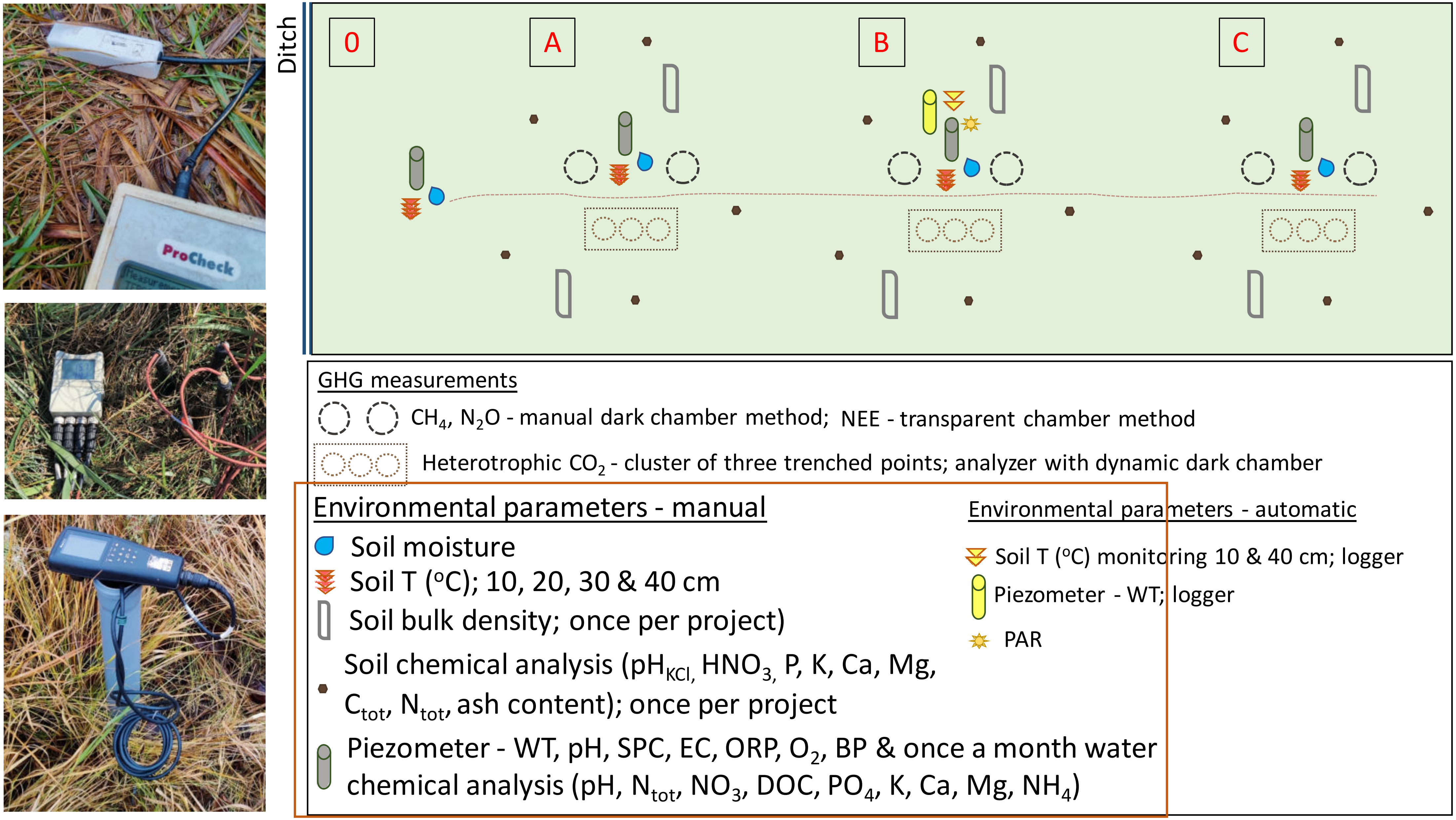
Groups	Site ID	Land use type	Organic layer depth	Water table regime	Water table
I group Drained cropland	01EE	Cropland	~35 cm	Drained site	~55 cm
	01LV		~30 cm		~60 cm
	01LT		~45 cm		~60 cm
II group Well drained grassland	02EE	Grassland	~45 cm	Drained site	~60 cm
	02LV		~50 cm		~60 cm
	02LT		~50 cm		~50 cm
III group Moderately drained grassland	03EE	Grassland	~35 cm	Drained site	~25 cm
	03LV		~35 cm		~25 cm
IV group Poorly drained grassland	07EE	Grassland	>1 m	Drained site	~30 cm
	07LT		>2 m		~10 cm
V group Floodplain fen	10EE	Floodplain fen	>2 m	Naturally wet	~40 cm
VI group Fen	10LV	Fen	>2 m	Naturally wet	~15 cm
	10LT		>2 m		~10 cm

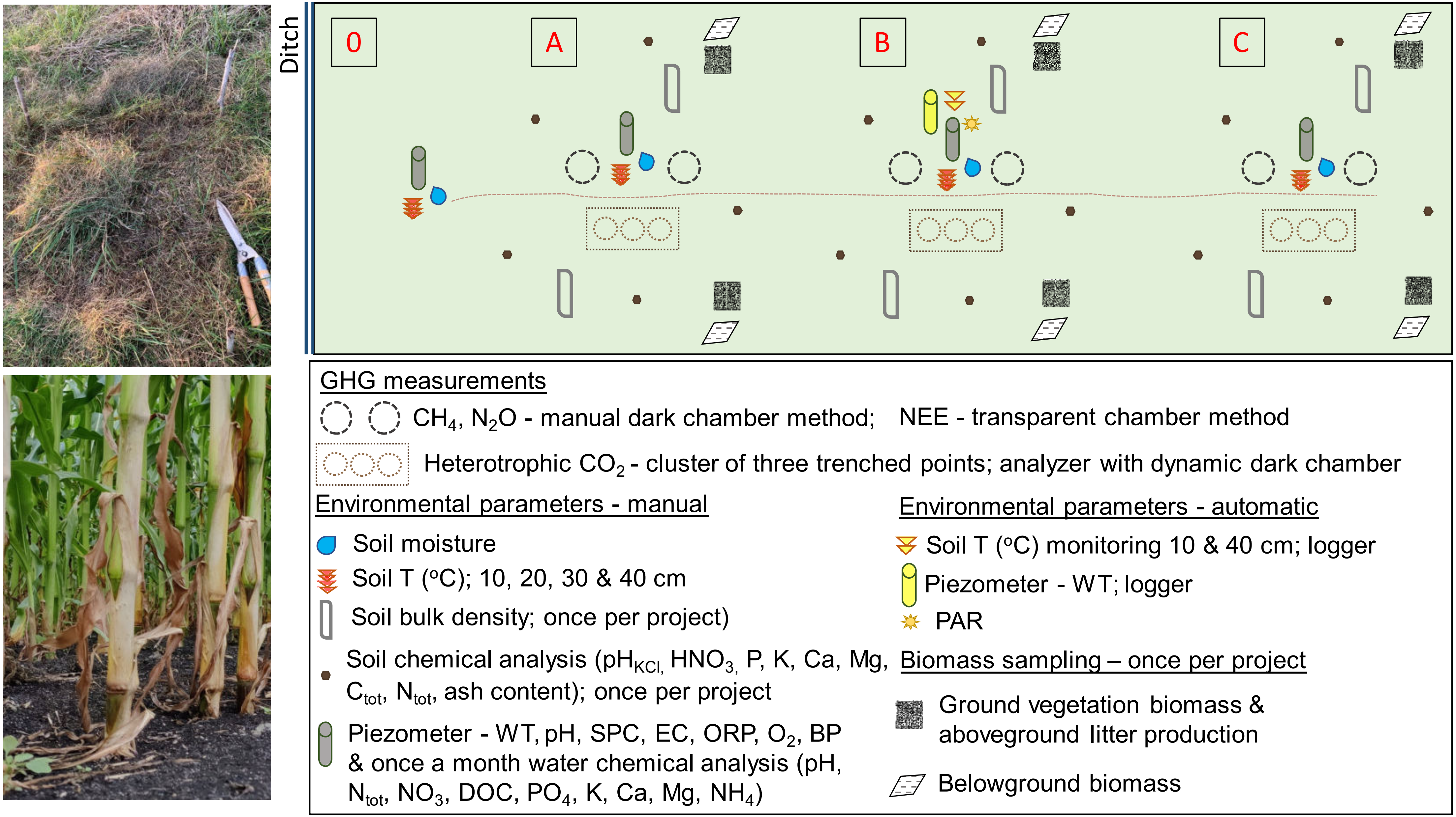

(III) Moderately drained grassland
C
B
A
Ranna tee
Ranna tee
Suuresilla
A
B
C
(IV) Poorly drained grassland
Ditch
(II) Well drained grassland
A
B
C
2
C
B
A
Ditch
(I) Drained cropland


22142
A
B
C
(V) Floodplain fen

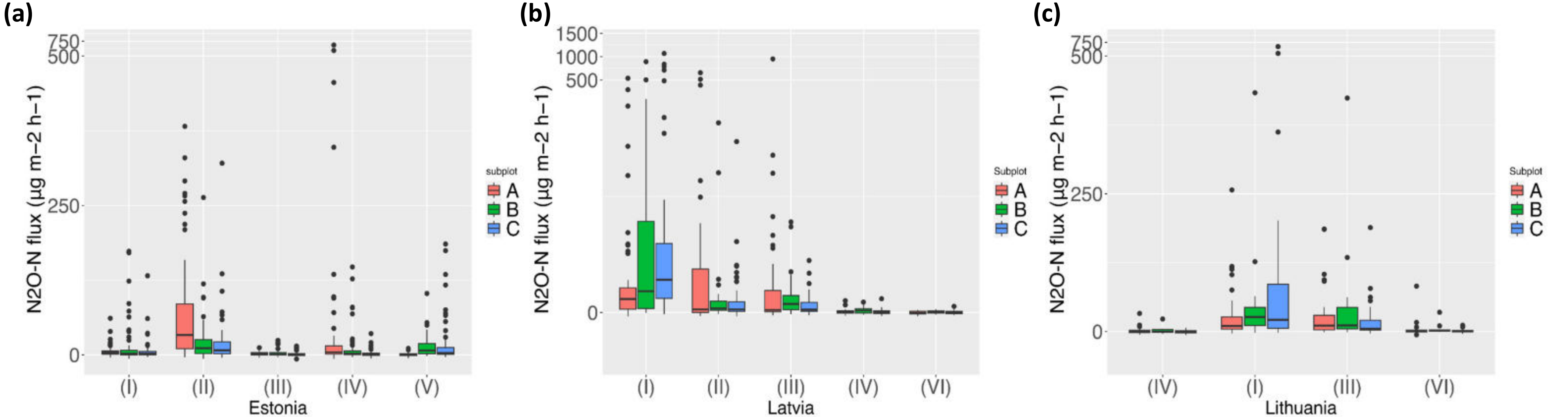

Ditch
0
A
B
C
Walking path
GHG measurements
CH_4, N_2O - manual dark chamber method; NEE - transparent chamber method
Heterotrophic CO_2 - cluster of three trenched points; analyzer with dynamic dark chamber

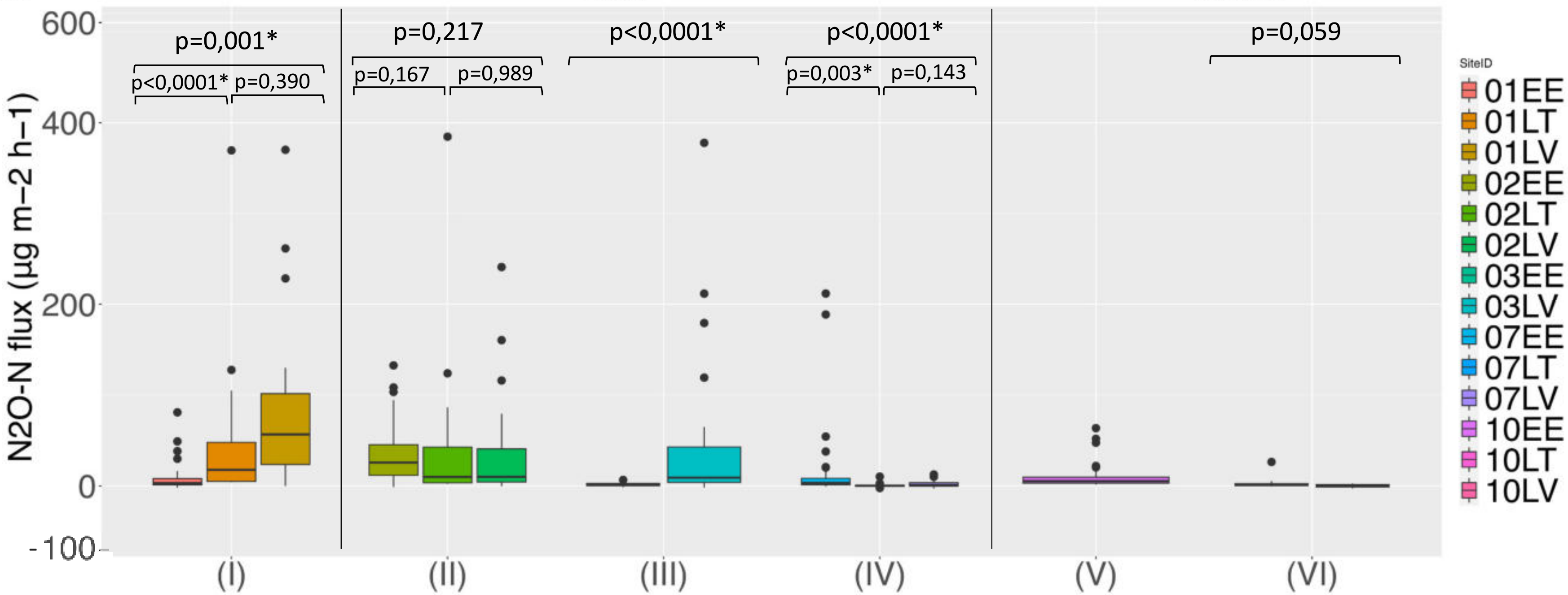

Ditch
0
A
B
C
Walking path
GHG measurements
CH_4, N_2O - manual dark chamber method; NEE - transparent chamber method
Heterotrophic CO_2 - cluster of three trenched points; analyzer with dynamic dark chamber
Environmental parameters - automatic
Soil T (°C) monitoring 10 & 40 cm; logger
Piezometer - water table (WT); logger
PAR (photosynthetically active radiation)


ProCheck
Ditch
0
A
B
C
GHG measurements
CH4, N2O - manual dark chamber method; NEE - transparent chamber method
Heterotrophic CO2 - cluster of three trenched points; analyzer with dynamic dark chamber
Environmental parameters - manual
Soil moisture
Soil T (°C); 10, 20, 30 & 40 cm
Soil bulk density; once per project)
Soil chemical analysis (pHKCl, HNO3, P, K, Ca, Mg, Ctot, Ntot, ash content); once per project
Piezometer - WT, pH, SPC, EC, ORP, O2, BP & once a month water chemical analysis (pH, Ntot, NO3, DOC, PO4, K, Ca, Mg, NH4)
Environmental parameters - automatic
Soil T (°C) monitoring 10 & 40 cm; logger
Piezometer - WT; logger
PAR

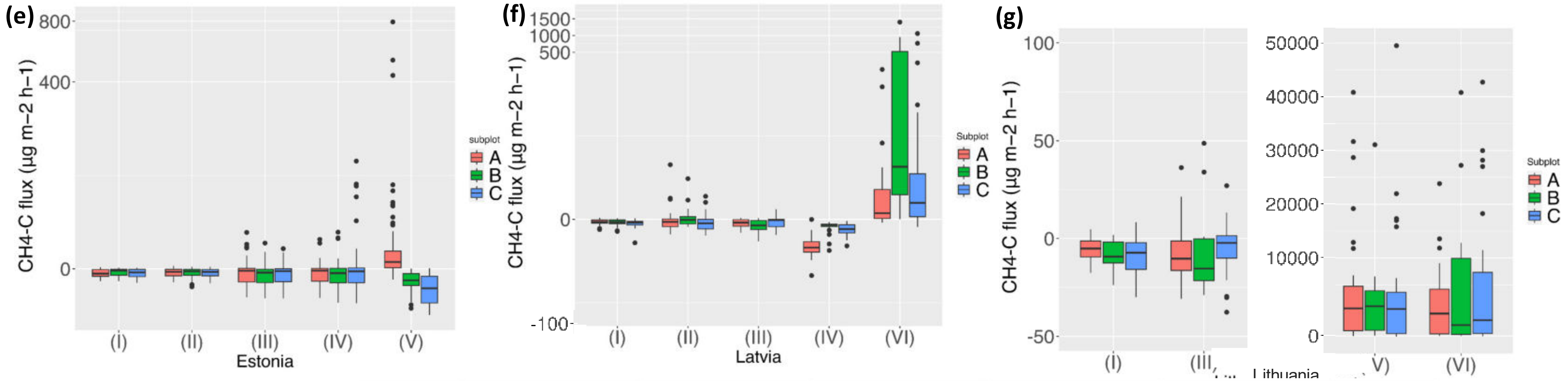

Ditch
0
A
B
C
GHG measurements
CH4, N2O - manual dark chamber method; NEE - transparent chamber method
Heterotrophic CO2 - cluster of three trenched points; analyzer with dynamic dark chamber
Environmental parameters - manual
Soil moisture
Soil T (°C); 10, 20, 30 & 40 cm
Soil bulk density; once per project
Soil chemical analysis (pHKCl, HNO3, P, K, Ca, Mg, Ctot, Ntot, ash content); once per project
Piezometer - WT, pH, SPC, EC, ORP, O2, BP & once a month water chemical analysis (pH, Ntot, NO3, DOC, PO4, K, Ca, Mg, NH4)
Environmental parameters - automatic
Soil T (°C) monitoring 10 & 40 cm; logger
Piezometer - WT; logger
PAR
Biomass sampling – once per project
Ground vegetation biomass & aboveground litter production
Belowground biomass

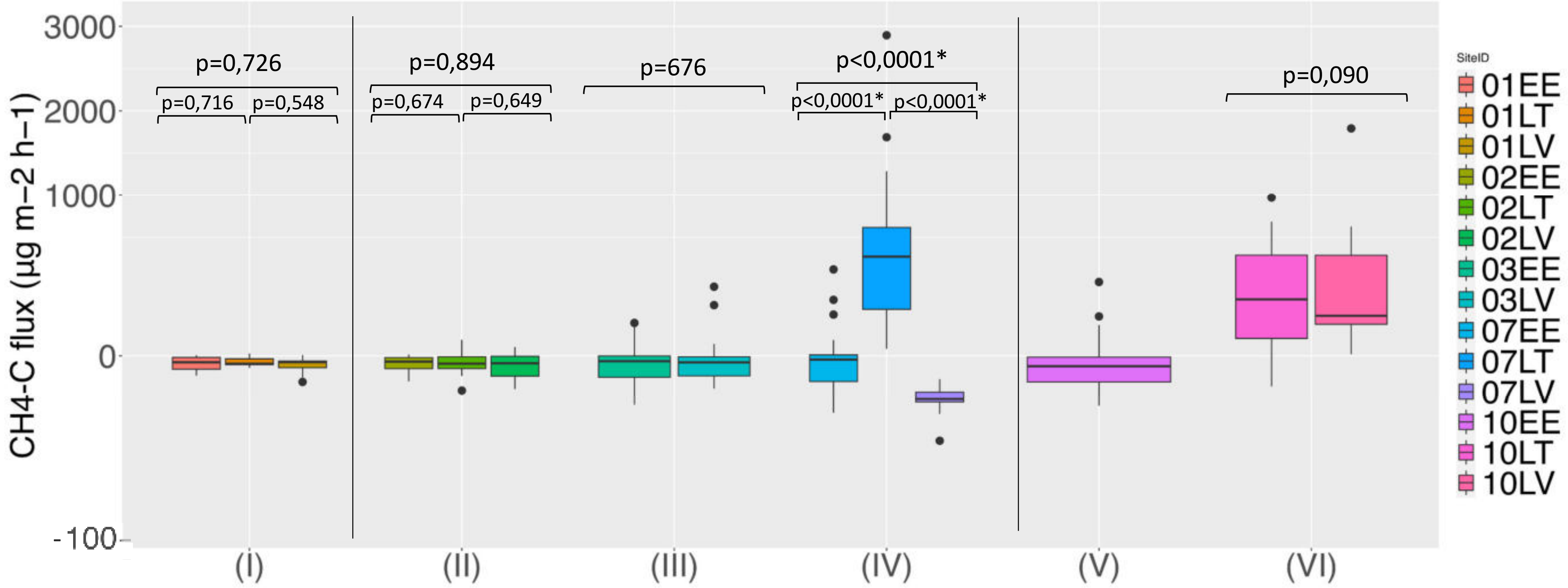
Results





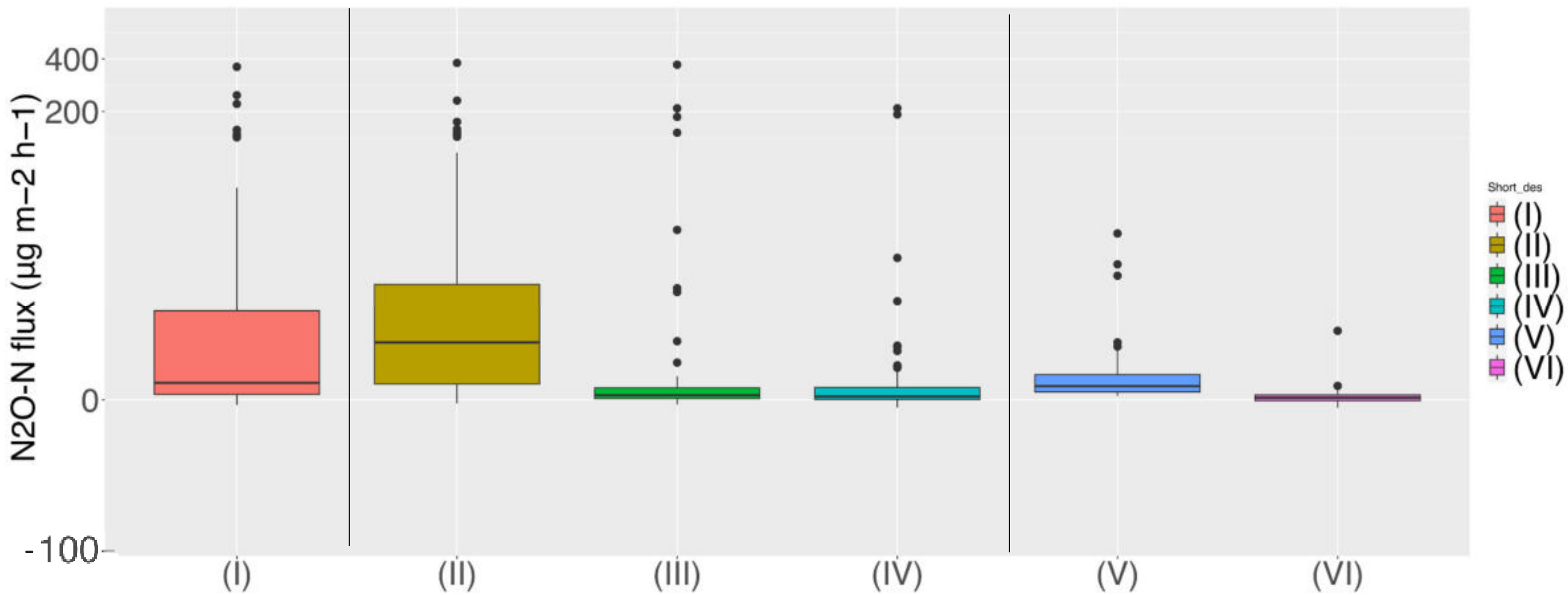
(d). Boxplots showing the N_2O-N emission by different groups with different water level split by countries. Median, 25–75 quartiles, minmax, and outliers are presented.



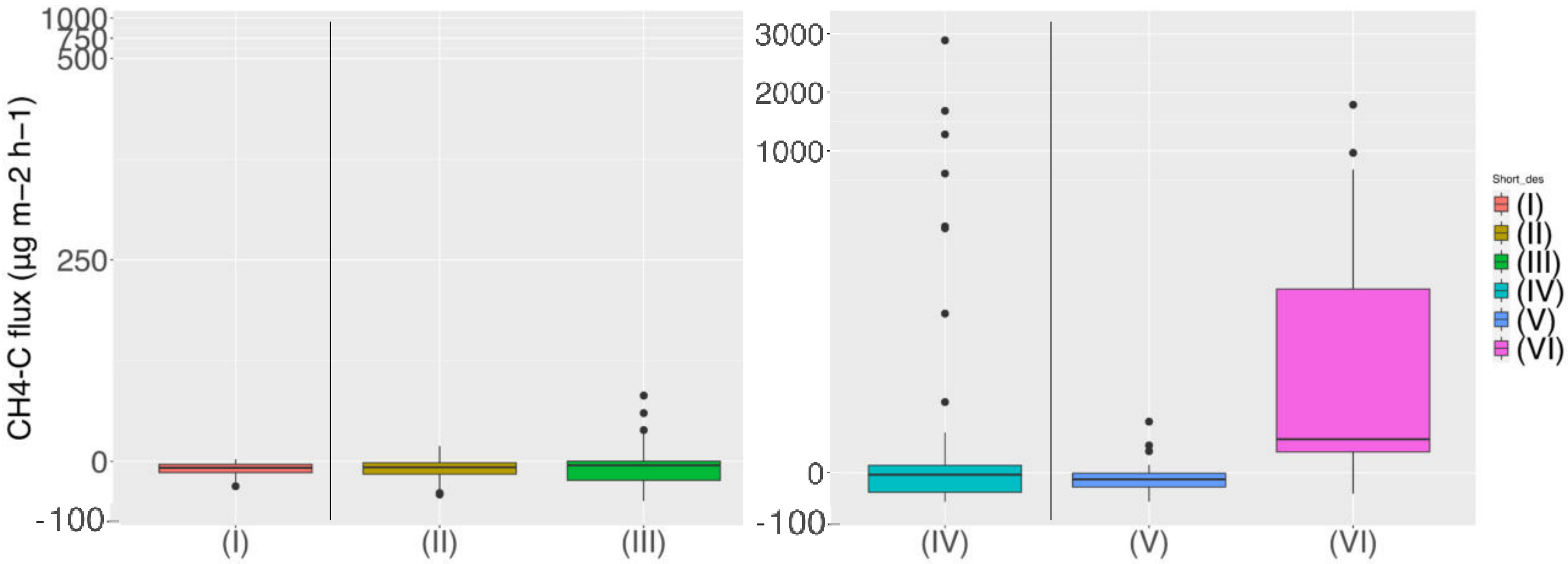


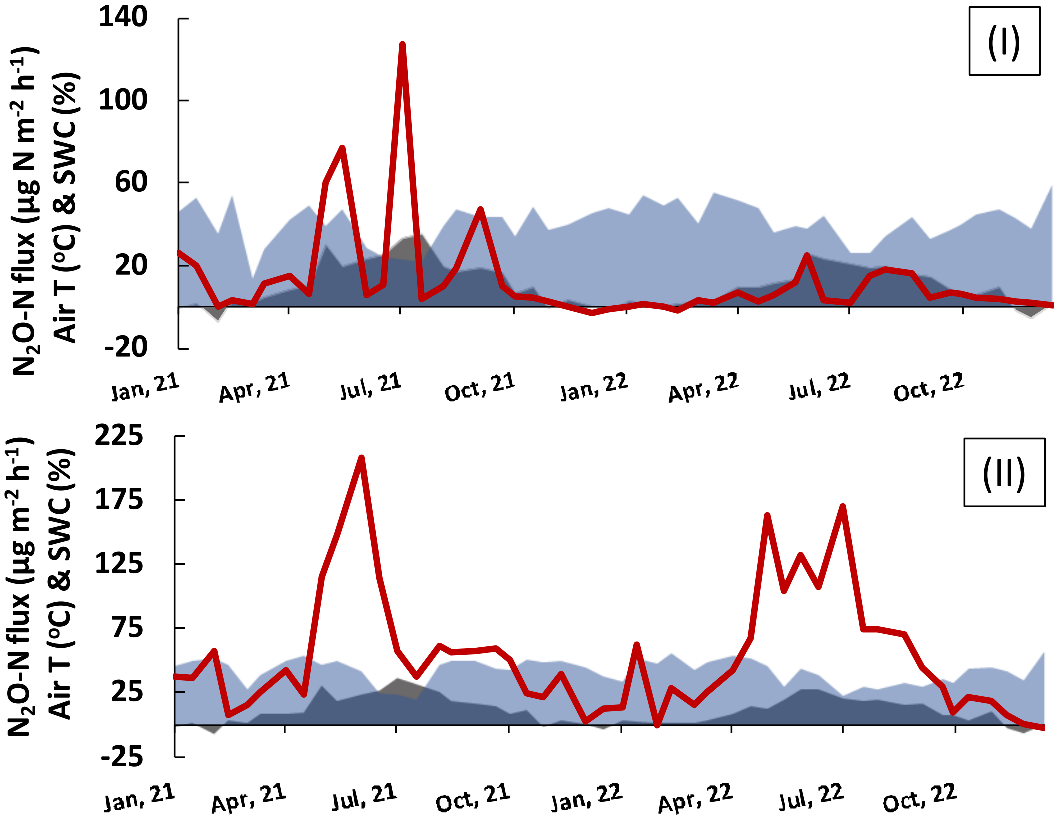
(h). Boxplots showing the CH_4-C emission by different groups with different water level split by countries. Median, 25–75 quartiles, minmax, and outliers are presented.

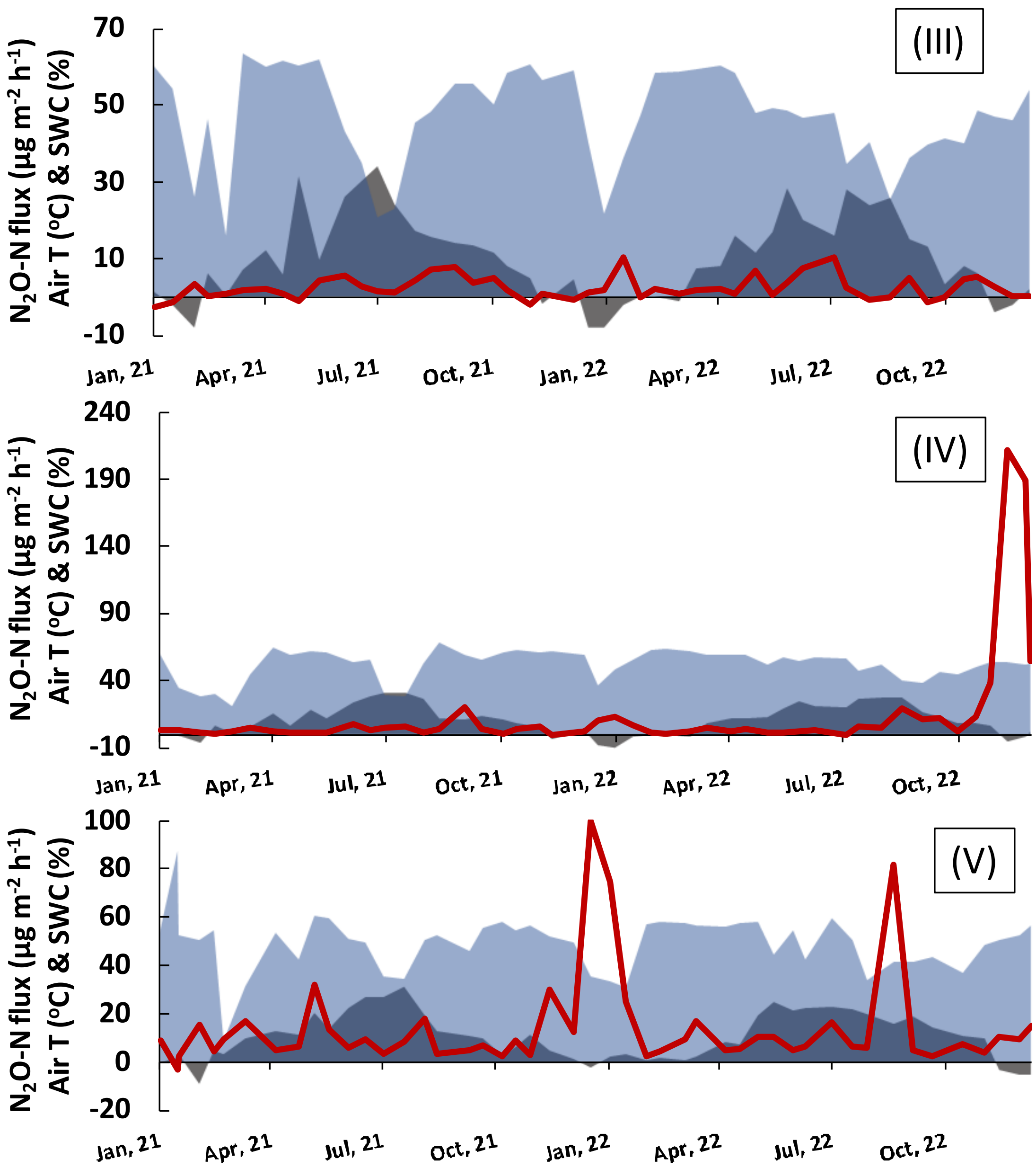
(i) Boxplots showing the N_2O-N emission in groups with different water level. Median, 25–75 quartiles, minmax, and outliers are presented.



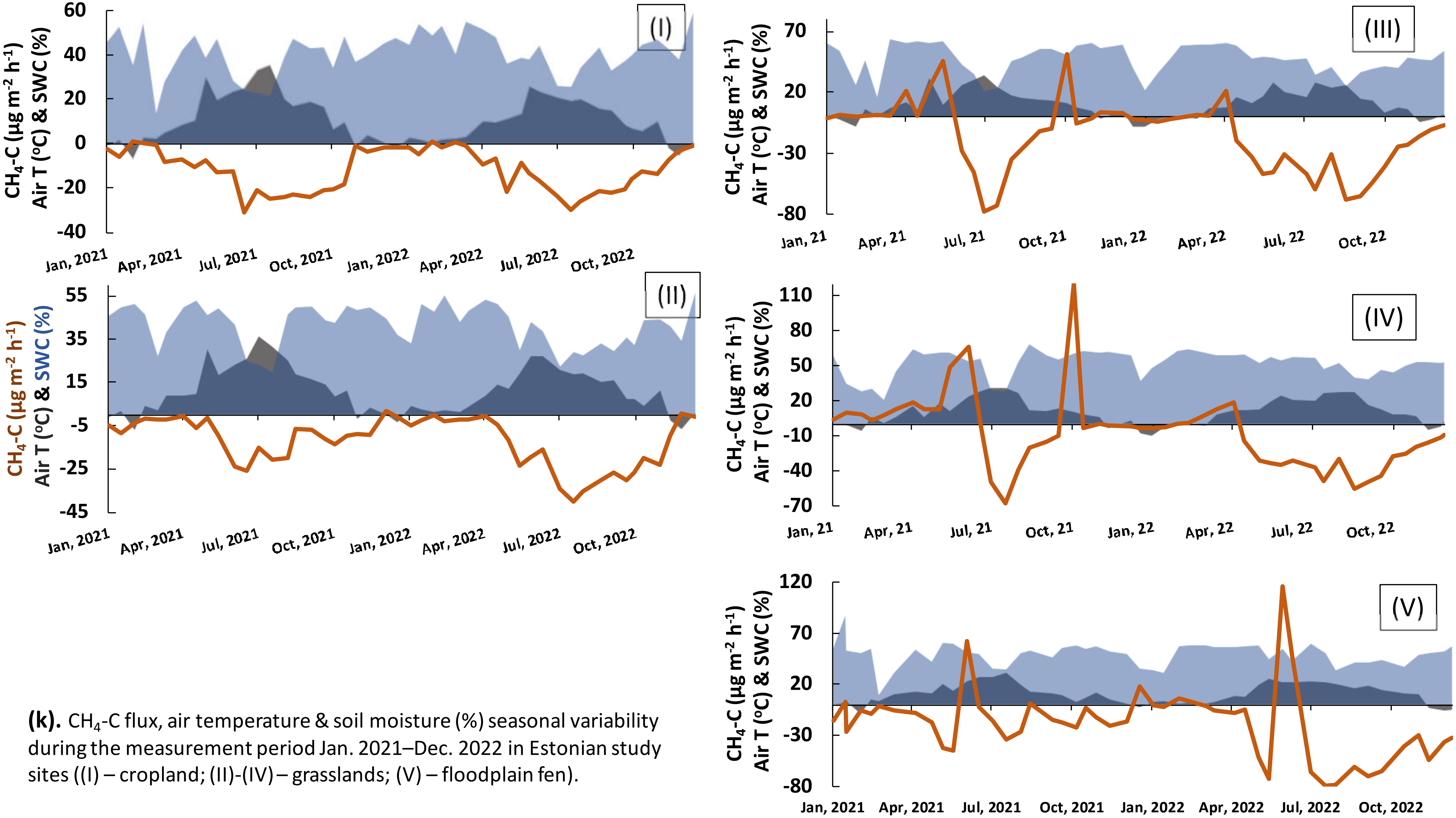
(j) Boxplots showing the CH_4-C emission in groups with different water level. Median, 25–75 quartiles, minmax, and outliers are presented.







(k). N_2O-N flux, air temperature & soil moisture (%) seasonal variability during the measurement period Jan. 2021–Dec. 2022 in Estonian study sites ((I) – cropland; (II)-(IV) – grasslands; (V) – floodplain fen).



(k). CH_4-C flux, air temperature & soil moisture (%) seasonal variability during the measurement period Jan. 2021–Dec. 2022 in Estonian study sites ((I) – cropland; (II)-(IV) – grasslands; (V) – floodplain fen).

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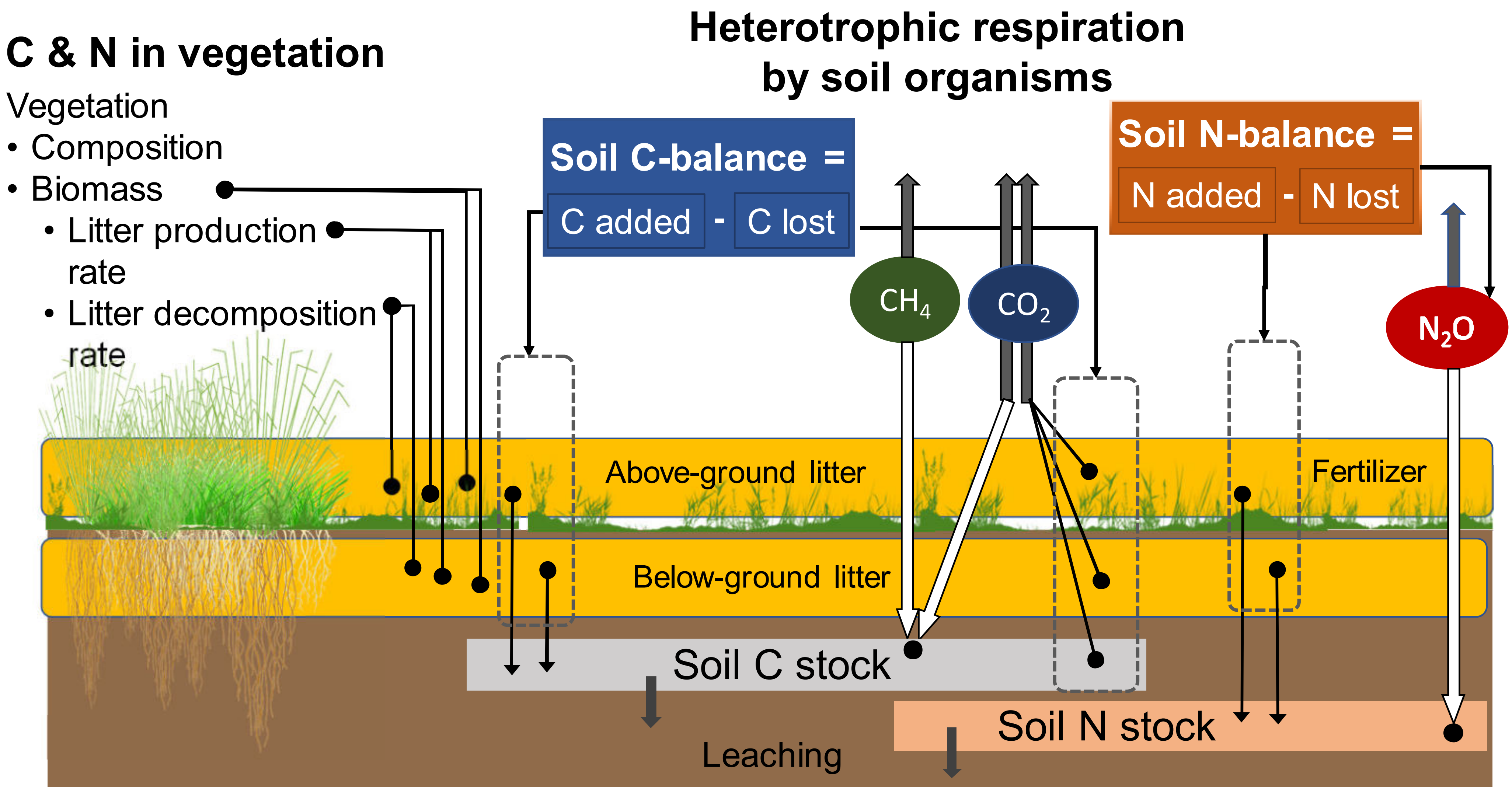
Summary

- High seasonal variability of N_2O and CH_4 fluxes;
- Croplands (I) and two grassland groups (II; III) were annual CH_4 sinks (emissions varied from -58.27 to 81.66 µg m^{-2} h^{-1}),
  - fens soils with higher groundwater levels were a source of CH_4 (emissions varied up to 45 584.60 µg m^{-2} h^{-1});
- All studied sites were annual emitters of N_2O (emissions varied from -2.91 to 3789.57 µg m^{-2} h^{-1});
  - Cropland (I) soils were the highest N_2O emitters (average emission 75.38±22.54 µg m^{-2} h^{-1}).



C & N in vegetation
Vegetation
• Composition
• Biomass
• Litter production rate
• Litter decomposition rate
Heterotrophic respiration by soil organisms
Soil C-balance =
C added - C lost
Soil N-balance =
N added - N lost
CH_4
CO_2
N_2O
Above-ground litter
Fertilizer
Below-ground litter
Soil C stock
Soil N stock
Leaching

Next important steps

- Continue with more in-depth data analysis (multicriteria; vegetation & non-vegetation periods etc.);
- Calculate GHG emission factors for GHG from drained peatland grasslands;
- C and N budget:
  - include heterotrophic CO_2 flux;
  - annual litter and biomass production;
  - C and N content in above & below ground biomass;
  - Include other inputs & outputs (etc fertilizer, dry deposition).

Thank you!

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Ministry of Agriculture Republic of Latvia
Latvia University of Life Sciences and Technologies
Luke
Lithuanian Research Centre for Agriculture and Forestry
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Greifswald Mire Centre