*Supplement of*

# Using automated transparent chambers to quantify $CO_2$ emissions and potential emission reduction by water infiltration systems in drained coastal peatlands in the Netherlands

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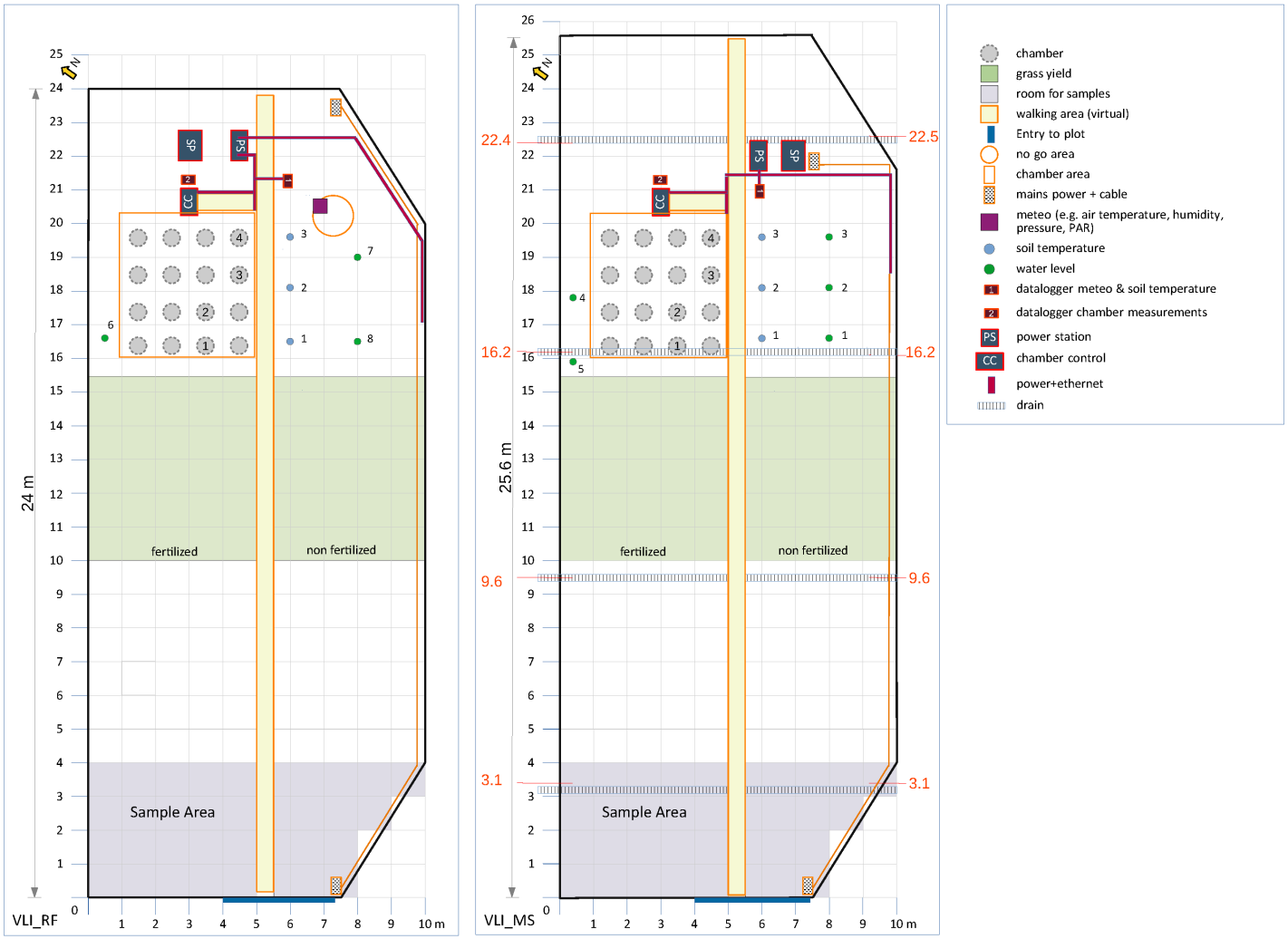


**Figure S1. Example of a technical drawing of the measurement plots for a location (VLI) with both a water infiltration system and control plot.**

**Table S1. Estimated carbon budgets, their standard deviation (SD) and average annual ($WTD_a$) and summer ($WTD_s$) water table depths. Net ecosystem carbon balance (NECB), net ecosystem exchange (NEE), gross primary production (GPP), ecosystem respiration ($R_{eco}$), and harvest are presented in t $CO_2$-C $ha^{-1}$ $yr^{-1}$. Annual (Cexp_a) and summer (Cexp_s) exposed carbon is presented in kg $m^{-2}$ $yr^{-1}$.**

| Loc | Treat-ment | Year | NECB | NECB SD | $CO_2$ flux data availability (%) | NEE | GPP | $R_{eco}$ | Harvest | Start date of NECB | End date of NECB | $WTD_a$ (cm) | $WTD_s$ (cm) | Cexp_a | Cexp_s |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ALB | CON | 2021 | 1.3[x] | 2.5[y] | 76.8 | -3.2[z] | | | 4.9 | 2021-01-01 | 2022-01-01 | 21 | 31 | 11.1 | 16.6 |
| ALB | CON | 2022 | 1.4[x] | 0.6 | 89.3 | -2.4 | 21.9 | 19.5 | 4.6 | 2022-01-01 | 2023-01-01 | 44 | 66 | 25.5 | 42.0 |
| ALB | CON | 2023 | -1.6[x] | 0.5 | 84.0 | -6.4 | 28.5 | 22.2 | 5.7 | 2022-11-14 | 2023-11-14 | 47 | 59 | 27.6 | 36.3 |
| ALB | WIS | 2021 | 3.0[x] | 0.6[y] | 37.2 | -1.4[z] | | | 4.9 | 2021-01-01 | 2022-01-01 | 30 | 32 | 18.2 | 19.5 |
| ALB | WIS | 2022 | -0.1[x] | 0.5 | 81.0 | -3.7 | 19.8 | 16.1 | 4.5 | 2021-11-14 | 2022-11-14 | 37 | 45 | 22.5 | 28.7 |
| ALB | WIS | 2023 | -0.4[x] | 0.5 | 93.4 | -5.1 | 24.9 | 19.7 | 5.6 | 2022-11-14 | 2023-11-14 | 29 | 37 | 17.4 | 22.5 |
| ASD | CON | 2020 | 3.4 | 1.1 | 93.3 | -4.3 | 26.8 | 22.5 | 7.7 | 2020-04-01 | 2021-04-01 | 38 | 65 | 30.3 | 53.2 |
| ASD | CON | 2021 | 4.4 | 0.7 | 91.4 | -4.4 | 23.0 | 18.6 | 8.7 | 2021-01-01 | 2022-01-01 | 25 | 32 | 20.4 | 24.9 |
| ASD | CON | 2022 | 0.9 | 0.6 | 90.5 | -5.0 | 19.3 | 14.3 | 5.9 | 2022-01-01 | 2023-01-01 | 44 | 68 | 36.3 | 55.3 |
| ASD | CON | 2023 | 5.6 | 0.6 | 87.1 | -0.9 | 21.3 | 20.4 | 6.5 | 2022-10-15 | 2023-10-14 | 40 | 59 | 32.4 | 48.5 |
| ASD | WIS | 2020 | 1.1 | 0.9 | 90.0 | -5.9 | 25.0 | 19.1 | 6.9 | 2020-04-01 | 2021-04-01 | 18 | 23 | 19.4 | 23.4 |
| ASD | WIS | 2021 | 2.6 | 0.9 | 88.8 | -4.5 | 21.0 | 16.5 | 7.1 | 2021-01-01 | 2022-01-01 | 24 | 31 | 24.2 | 29.7 |
| ASD | WIS | 2022 | 1.2 | 0.8 | 93.9 | -4.7 | 20.5 | 15.7 | 5.9 | 2022-01-01 | 2023-01-01 | 30 | 38 | 28.9 | 35.4 |
| ASD | WIS | 2023 | 0.5 | 0.6 | 85.3 | -5.5 | 21.6 | 16.1 | 6.0 | 2022-10-15 | 2023-10-15 | 27 | 38 | 26.5 | 35.4 |
| LAW | WIS | 2022 | 5.1 | 0.6 | 89.0 | -0.3 | 20.7 | 20.4 | 5.4 | 2022-02-01 | 2023-02-01 | 35 | 48 | 22.3 | 30.5 |
| LAW | WIS | 2023 | 4.3 | 0.5 | 92.0 | 0.0 | 25.0 | 25.0 | 4.3 | 2022-11-01 | 2023-11-01 | 32 | 45 | 20.8 | 28.4 |
| ROV | CON | 2021 | 4.9 | 2.6[y] | 64.6 | -0.7[z] | | | 5.5 | 2021-01-01 | 2022-01-01 | 37 | 41 | 20.4 | 22.6 |
| ROV | CON | 2022 | 1.0 | 0.3 | 90.9 | -4.5 | 20.6 | 16.0 | 5.5 | 2021-12-27 | 2022-12-27 | 37 | 47 | 20.6 | 25.8 |
| ROV | CON | 2023 | 2.7 | 0.6 | 85.9 | -5.1 | 22.7 | 17.6 | 7.8 | 2022-12-27 | 2023-12-27 | 27 | 32 | 14.1 | 17.1 |
| ROV | WIS | 2021 | 5.3 | 2.4[y] | 67.2 | -1.0[z] | | | 6.4 | 2021-01-01 | 2022-01-01 | 44 | 47 | 29.3 | 31.2 |
| ROV | WIS | 2022 | 3.3 | 0.3 | 90.3 | -2.2 | 18.0 | 15.8 | 5.5 | 2021-12-27 | 2022-12-27 | 48 | 53 | 31.6 | 34.6 |
| ROV | WIS | 2023 | 3.6 | 0.5 | 91.3 | -3.6 | 24.8 | 21.1 | 7.3 | 2022-12-27 | 2023-12-27 | 42 | 46 | 27.9 | 30.4 |
| VLI | CON | 2020 | 5.8 | 1.3 | 76.4 | -2.1 | 27.7 | 26.3 | 8.0 | 2020-04-01 | 2021-04-01 | 51 | 70 | 44.5 | 57.7 |
| VLI | CON | 2021 | 5.7 | 0.7 | 94.5 | -3.1 | 23.5 | 20.4 | 8.8 | 2021-01-01 | 2022-01-01 | 43 | 59 | 38.5 | 50.6 |
| VLI | CON | 2022 | 7.6 | 0.6 | 84.9 | 0.1 | 21.1 | 21.2 | 7.5 | 2022-01-01 | 2023-01-01 | 52 | 69 | 45.4 | 57.1 |
| VLI | CON | 2023 | 6.3 | 0.4 | 92.3 | -0.6 | 21.0 | 20.4 | 6.9 | 2022-10-15 | 2023-10-15 | 48 | 67 | 42.1 | 56.0 |
| VLI | WIS | 2020 | 4.2 | 0.7 | 78.3 | -3.2 | 24.8 | 21.3 | 7.4 | 2020-04-01 | 2021-04-01 | 51 | 61 | 43.1 | 51.0 |
| VLI | WIS | 2021 | 2.9 | 0.6 | 93.0 | -4.2 | 21.4 | 17.2 | 7.1 | 2021-01-01 | 2022-01-01 | 47 | 57 | 39.7 | 48.2 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| VLI | WIS | 2022 | 6.6 | 0.6 | 87.7 | -0.5 | 19.6 | 19.0 | 7.1 | 2022-01-01 | 2023-01-01 | 50 | 60 | 42.3 | 50.4 |
| VLI | WIS | 2023 | 2.8 | 0.5 | 90.3 | -4.1 | 22.9 | 18.8 | 6.8 | 2022-10-15 | 2023-10-01 | 47 | 61 | 39.7 | 51.0 |
| ZEG | CON | 2021 | 7.8 | 0.7 | 61.2 | -0.5 | 19.5 | 19.1 | 8.2 | 2021-01-01 | 2022-01-01 | 45 | 66 | 47.5 | 65.5 |
| ZEG | CON | 2022 | 4.6 | 0.8 | 66.8 | -2.2 | 26.0 | 23.8 | 6.9 | 2021-11-01 | 2022-11-01 | 50 | 74 | 51.0 | 76.3 |
| ZEG | CON | 2023 | 3.7 | 0.8 | 88.1 | -1.7 | 23.9 | 22.3 | 5.4 | 2022-11-01 | 2023-11-01 | 37 | 57 | 38.2 | 62.9 |
| ZEG | WIS1 | 2021 | 5.0 | 0.9 | 80.0 | -3.9 | 19.7 | 15.8 | 9.0 | 2021-01-01 | 2022-01-01 | 40 | 48 | 36.9 | 41.6 |
| ZEG | WIS1 | 2022 | 2.2 | 0.7 | 75.2 | -5.0 | 24.2 | 19.2 | 7.2 | 2022-01-01 | 2023-01-01 | 41 | 53 | 37.4 | 45.4 |
| ZEG | WIS1 | 2023 | 2.6 | 0.5 | 85.9 | -2.5 | 27.1 | 24.6 | 5.1 | 2022-11-01 | 2023-11-01 | 33 | 47 | 31.1 | 43.0 |
| ZEG | WIS2 | 2022 | 2.0 | 0.4 | 66.1 | -1.7 | 23.1 | 21.4 | 3.7 | 2022-02-01 | 2023-02-01 | 15 | 18 | 15.4 | 18.1 |
| ZEG | WIS2 | 2023 | 1.5 | 0.5 | 82.4 | -2.6 | 25.2 | 22.6 | 4.1 | 2022-11-01 | 2023-11-01 | 15 | 19 | 15.4 | 19.0 |

[x]Including fertilisation of organic manure of 0.32 and 0.53 t $CO_2$-C $ha^{-1}$ $yr^{-1}$ for ALB CON and WIS 2021, respectively, and 0.93 and 0.90 t $CO_2$-C $ha^{-1}$ $yr^{-1}$ for both ALB plots in 2022 and 2023, respectively. The SD of organic mature application was 50% of the estimate.

[y]NECB SD was roughly estimated and is highly uncertain due to large data gaps in $CO_2$ fluxes.

[z]NEE was gapfilled using Random Forest instead of the Lloyd-Taylor approach. This also resulted in NEE not being partitioned into GPP and Reco. We used the same input variables as used in the Lloyd-Taylor approach. A regression forest was trained with the flags n_subfeatures = -1 (number of features to consider at random per split, in this case an infinite number); n_trees = 250 (number of trees to train); partial_sampling = 0.7 (fraction of samples to train each tree on); max_depth = -1 (maximum depth of the decision trees, grown to maximum extent, in our case no maximum depth); min_samples_leaf = 5 (the minimum number of samples each leaf needs to have at minimum); min_samples_split = 2 (the minimum number of samples in needed for a split) using the MLJ.jl and DecisionTree.jl packages in the Julia 1.8.3 environment. The choices made in were informed by iterative experimentation using latin hypercube sampling in the Julia 1.8.3 environment.

**Table S2. Model fits for the empirical relation between annual water table depth ($WTD_a$; m) and net ecosystem carbon balance (NECB; t $CO_2$-C $ha^{-1}$ $yr^{-1}$). Model slopes and intercepts are given with their 95% confidence interval (CI).**

| Type | Model equation | Slope | 95%CI slope* | Intercept | 95%CI intercept* | R-function {package} |
|---|---|---|---|---|---|---|
| Linear regression | lm(NECB ~ $WTD_a$) | 8.96 | 2.54–15.38 | -0.23 | -2.71–2.26 | *lm {stats}* |
| Robust linear regression | rlm(NECB ~ $WTD_a$) | 9.67 | 3.04–16.31 | -0.39 | -2.96–2.18 | *rlm {MASS}* |
| Deming regression** | deming(NECB ~ $WTD_a$, xstd = WTD_SD, ystd = NECB_SD*** | 15.13 | 5.12-–25.14 | -2.63 | -6.39– 1.13 | *deming {deming}* |
| Linear Mixed Effects Model | lmer(NECB ~ $WTD_a$ + (1\|Location/Year) | 5.95 | 0.008–11.94 | 0.93 | -1.60–3.46 | *lmer (lmerTest)* |

* To calculate CIs in R, we used the function confint.lm (package 'stats') for the simple linear regression. For robust linear regression, we also used the function confint.lm after obtaining the model's residual degrees of freedom using the summary.rlm function of the 'MASS' package. For Deming regression, CIs were given by printing the fitted model object. For the linear mixed effects model, we used the function confint.merMod (package 'lme4') to calculate CIs via parametric bootstrapping (100,000 bootstrap replicates).

** Estimated with standard deviation (SD) estimates for $WTD_a$ per site-year, based on groundwater well replicates ($n$=3). When well replicates were not present, average control site SD estimates were used. Estimates of the NECB SD were obtained as described in the main text.

*** WTD_SD and NECB_SD are the estimated standard deviations of the annual water table depth ($WTD_a$) and net ecosystem carbon balance (NECB), respectively.

**Table S3. Overview of fitted empirical relations to estimate net ecosystem carbon balance (NECB; t C $ha^{-1}$ $yr^{-1}$) based on mean annual water table depths ($WTD_a$) that are plotted in Figure 9 of the main text. Please note that the fit of Koch et al. (2023) is identical to the fit of Tiemeyer et al. (2020) and thus not separately included here.**

| Study | Function with parameters |
|---|---|
| *Current study* | $\mathrm{NECB} = 8.96\ \mathrm{WTD_a} - 0.23$ |
| *Couwenberg et al. (2011)* | $\mathrm{NECB} = 20.54\ \mathrm{WTD_a} - 1.29$ |
| *Fritz et al. (2017)* | $\mathrm{NECB} = 12.27\ \mathrm{WTD_a} - 0.02$ |
| *Tiemeyer et al. (2020)* | $\mathrm{NECB} = -0.93 + 11.00\ e^{-7.52\ e^{12.97\ \mathrm{WTD_a}}}$ |
| *Evans et al. (2021)* | $\mathrm{NECB} = 9.27\ \mathrm{WTD_a} - 1.69$ |

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