Deltares

United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme

Universiteit Utrecht

Land Subsidence and GHG emissions in the Dutch Peat Meadows

Gilles Erkens & many others

Chief land subsidence researcher at Deltares

Senior researcher Utrecht University

Member of the UNESCO Working Group of Land Subsidence (LASII)

Chief Scientist National Research Programme GHG emissions Dutch Peat Meadows

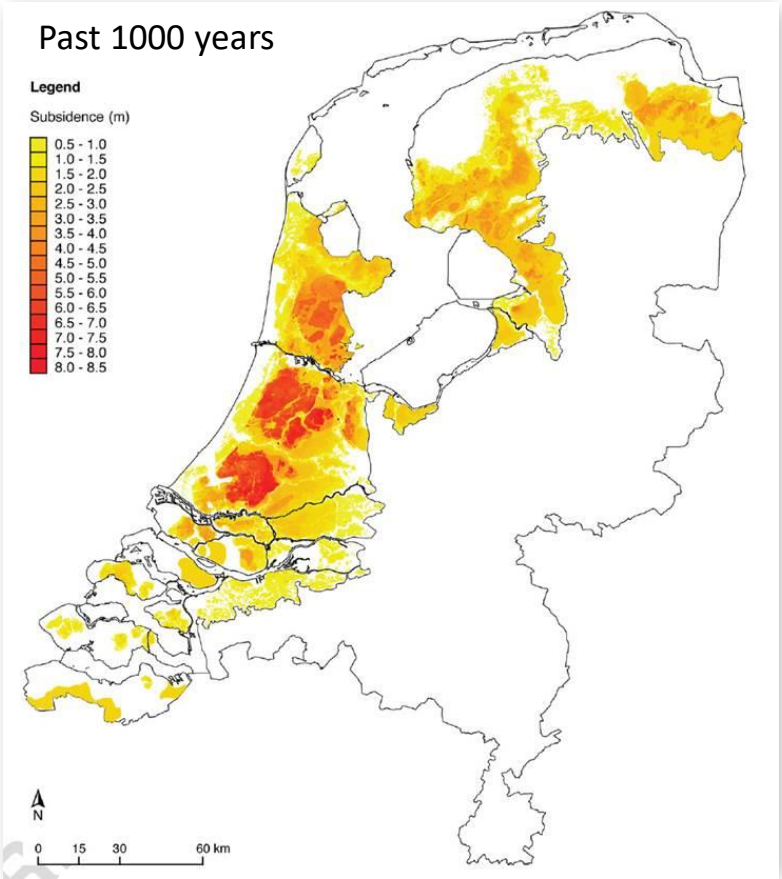
Nationaal Onderzoeksprogramma Broeikasgassen Veenweiden


The Dutch are admired for being able to
safely live in a country below sea level……,
but no one asks how we got there.

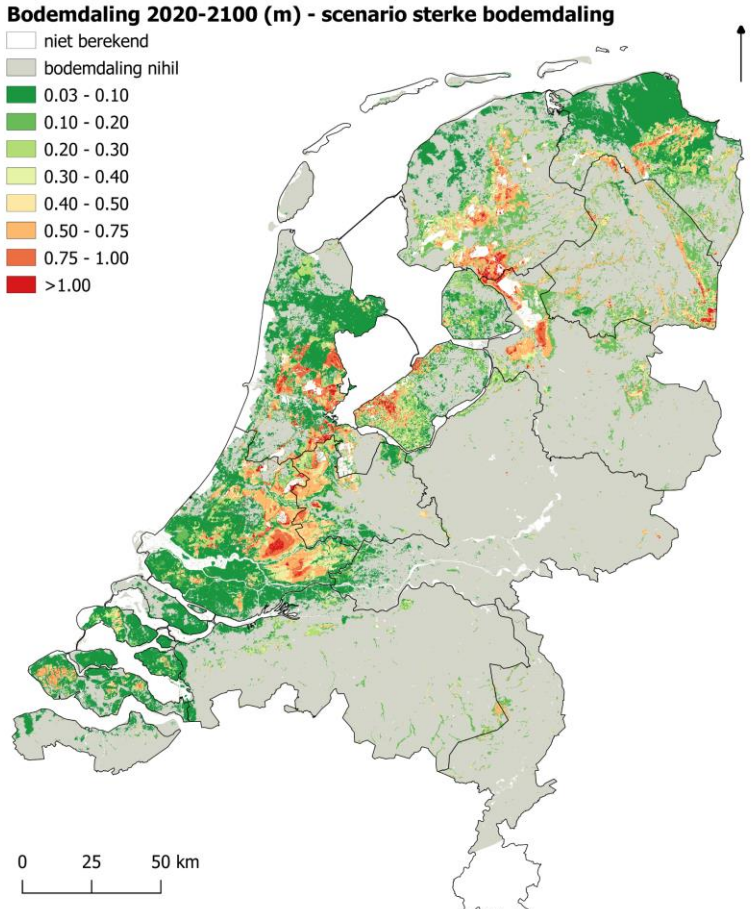
What happened with The Netherlands?

Future human-induced land subsidence and GHG emissions

Past 1000 years

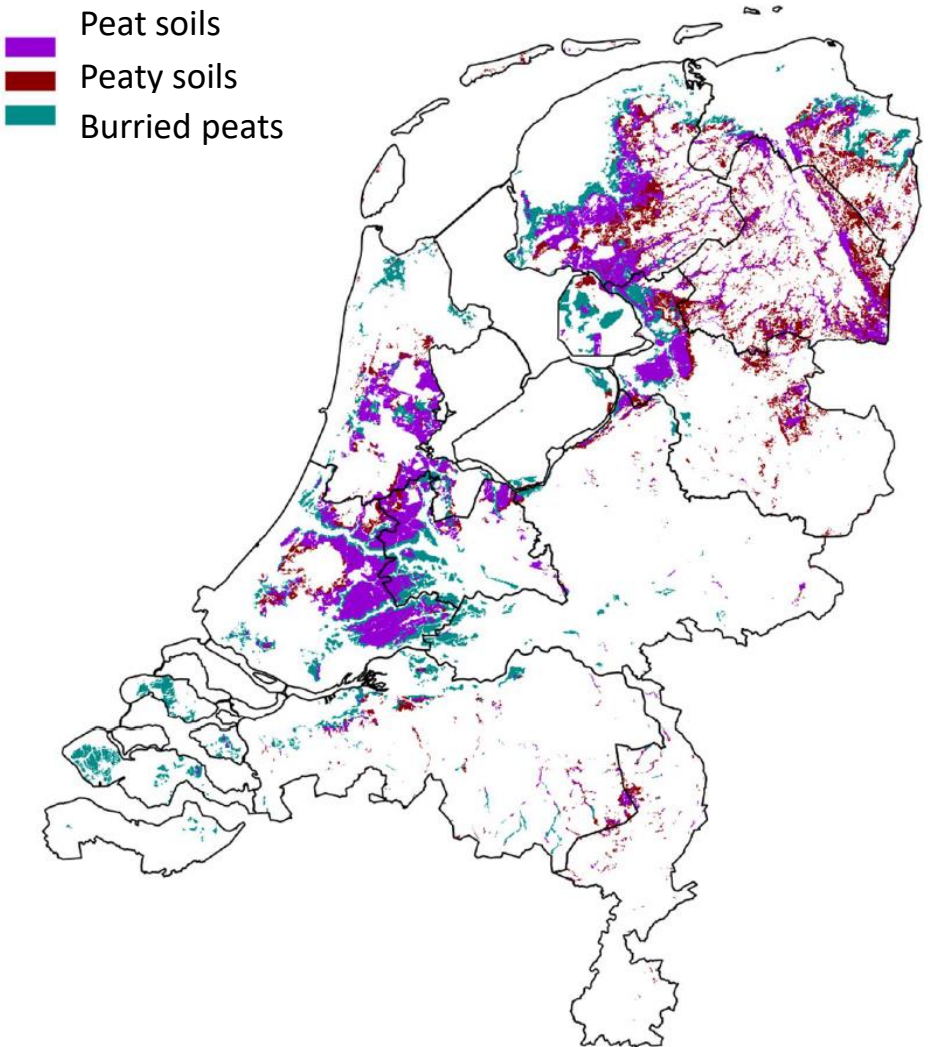


Coming decades

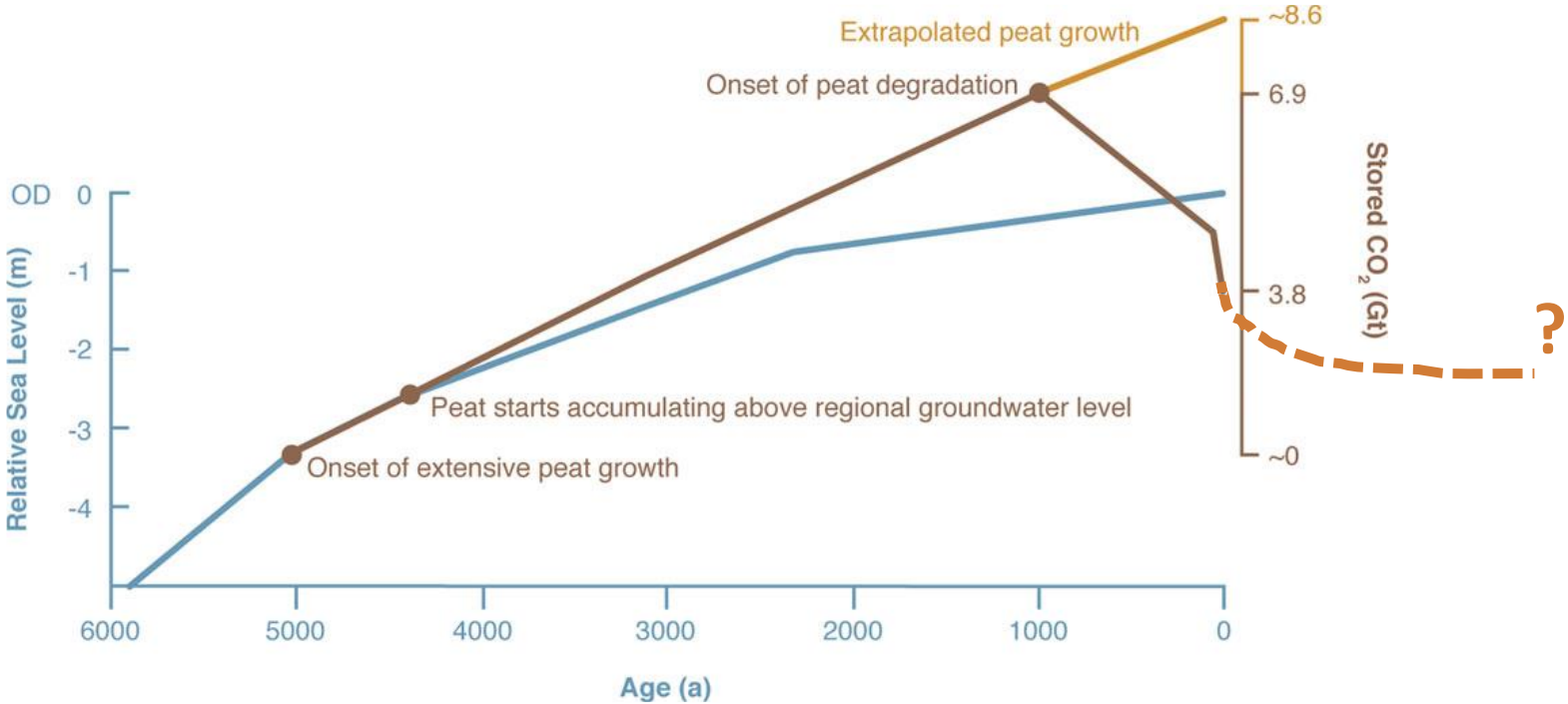


The Dutch peatlands

- 9% of the Netherlands contains organic soils
- Land use is mostly grassland and dairy farming
- Peat is drained with ditches, with drainage depths of 0-100 cm below surface
- Currently ~5.6 Mton CO_2 yr^{-1} emission (Ruyssenaars et al., 2020)
- National climate law and climate agreement: reduction of 1 Mton CO_{2eq} yr^{-1} in 2030



Bending the long term trend



- But what are effects of proposed measures?
- Where can we do what: what is spatially the most optimal combination of measures?

>> we need to understand the system much better, hence a National Research Programme

Erkens et al., 2016

Addition of clay

Submerged drains

Transition to wetland

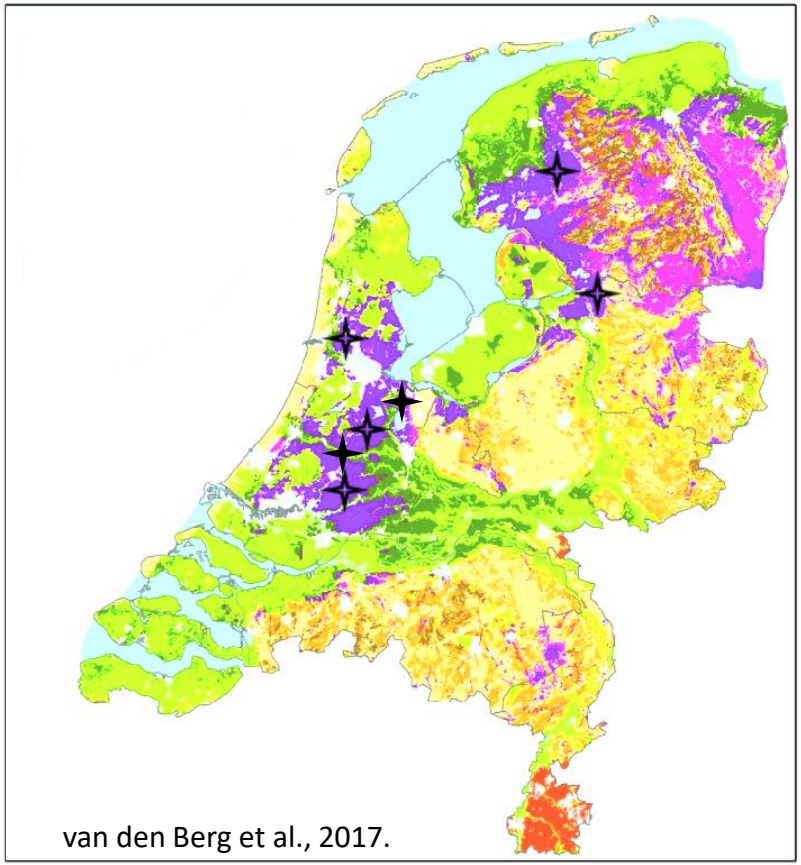
paludiculture

Studied measures

Research aims (4x)

1. To establish the **effects of measures** on the greenhouse gas emission and land subsidence in the peat meadow areas
2. To establish **a measurement protocol** for greenhouse gas emission and land subsidence in the peat meadow areas
3. Updating and improving the **numerical models** used to greenhouse gas emission and land subsidence in the peat meadow areas
4. Building a nation-wide measurement network **to monitor** the greenhouse gas emission and land subsidence in the peat meadow areas on the long term.

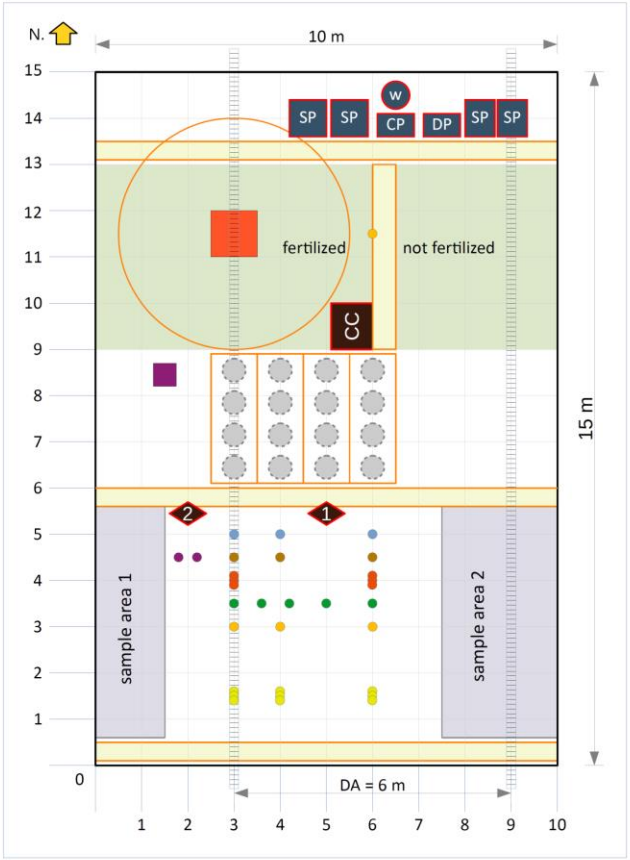
Measurement locations



van den Berg et al., 2017.

- 5x submerged drains
- 3x pressurised drains
- 2x paludiculture (*Typha latifolia*), Sphagnum
- 1x nature conservation
- 1x transition to wetland
- 2x extensively grazed grassland
- 1x peaty soil

Measurement site set-up



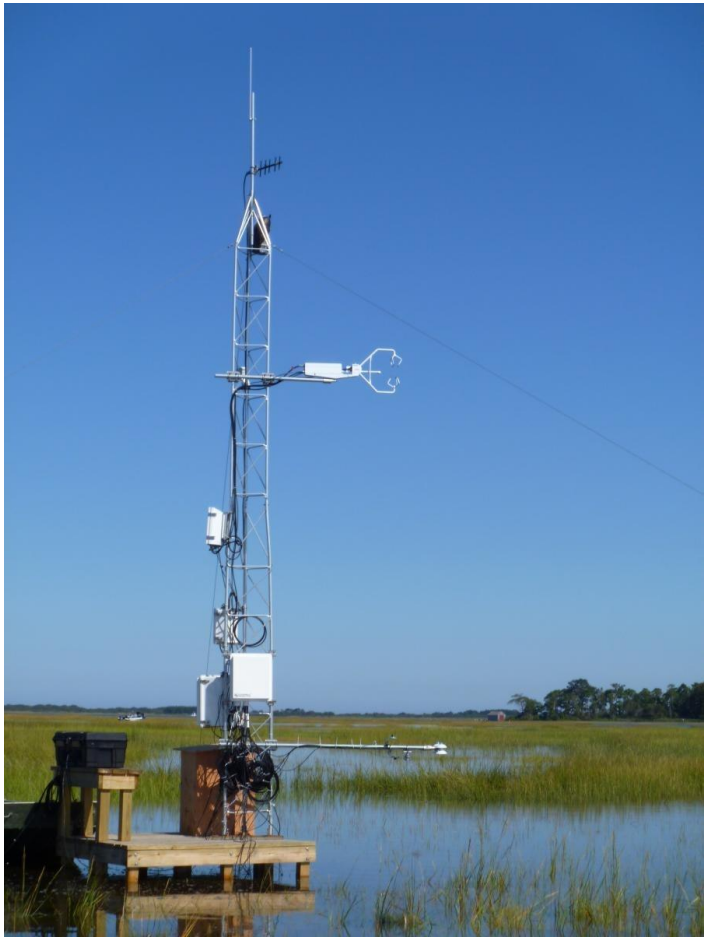
ZEG_MD

- extensometer
- chamber
- grass yield
- room for samples
- no go area
- chamber area
- walking area (virtual)
- meteo humidity/temp/baro/wind/rain
  meteo LW/SW/PAR in/out or SRS
- soilmoisture
- redox
- oxygen
- waterlevel
- biochemical sampling /pore water
- tensio measurements
- meteo heatflux
- 1 datalogger redox
- 2 datalogger meteo/soilmoisure/tensio
- CC chamber controlbox
- SP solar panels
- W (small) windgenerator
- DP dataloggers power
- CP chamber power

Date 25-06-19 version 1.0

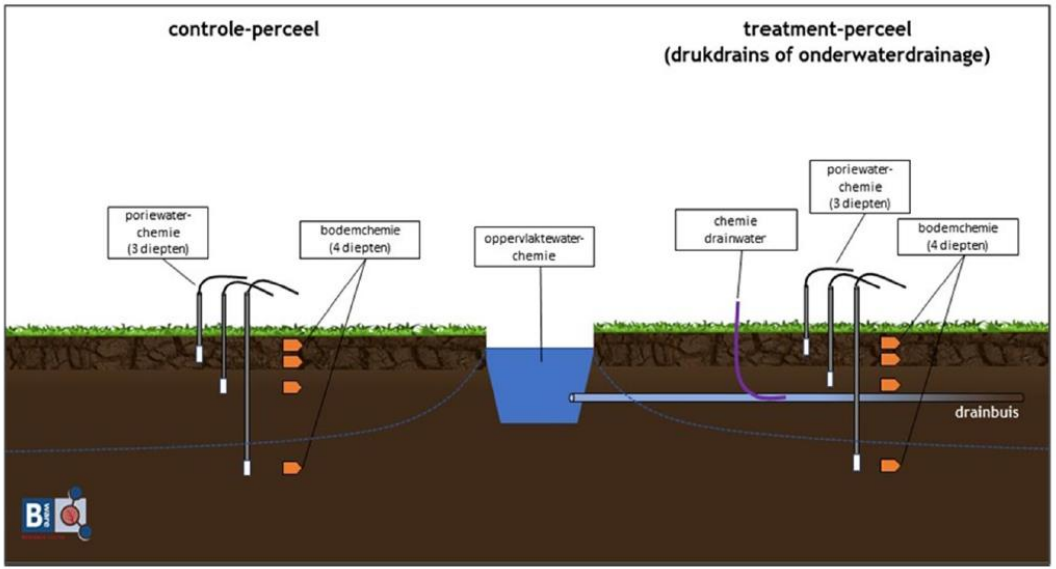
GHG measurements with automatic closed chambers and eddy covariance towers

>> to investigate the effects of measures and to build a database of correlating parameters

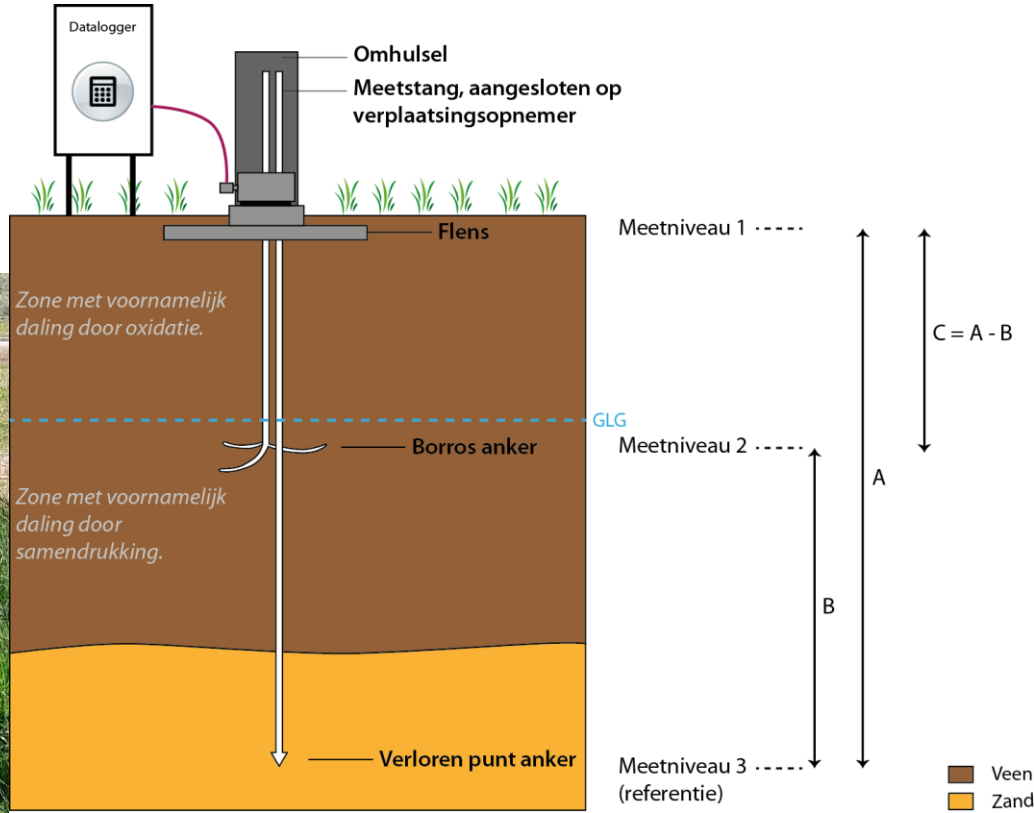


Soil and water measurements

Sensors for: soil moisture, soil temperature, oxygen availability, and meteorological parameters.
Samples of microbiological assemblages, geological and soil mechanical parameters, biogeochemical parameters.



Land subsidence measurements

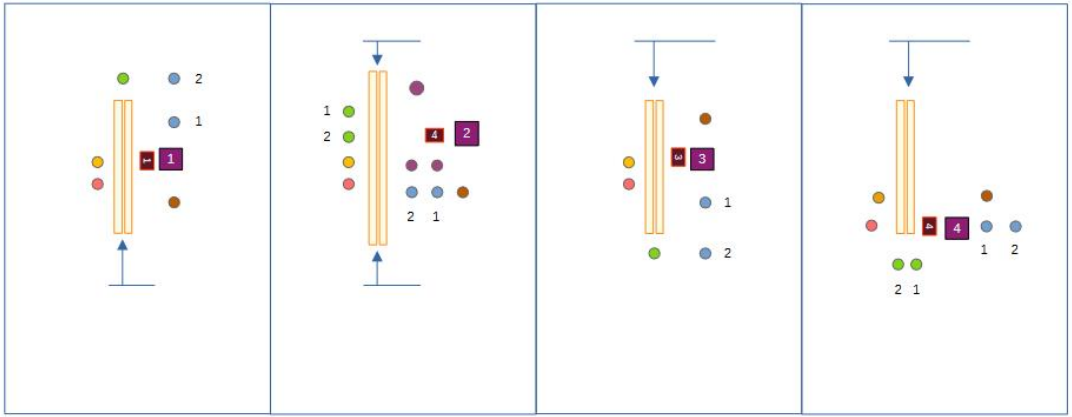


ANK_PT01..PT04*1

Plot 1: Typha latifolia
Plot 2: Juncu/grasses + Typha seed/plant
Plot 3: Typha Angustifolia
Plot 4: Carex
Plot 5: Phragmites
Plot 6: Spahagnum
Plot 7: Holcus grasses
Plot 8: Typha angustifolia (new)

*1 Indication of sensor placement.
(Not exact on scale)

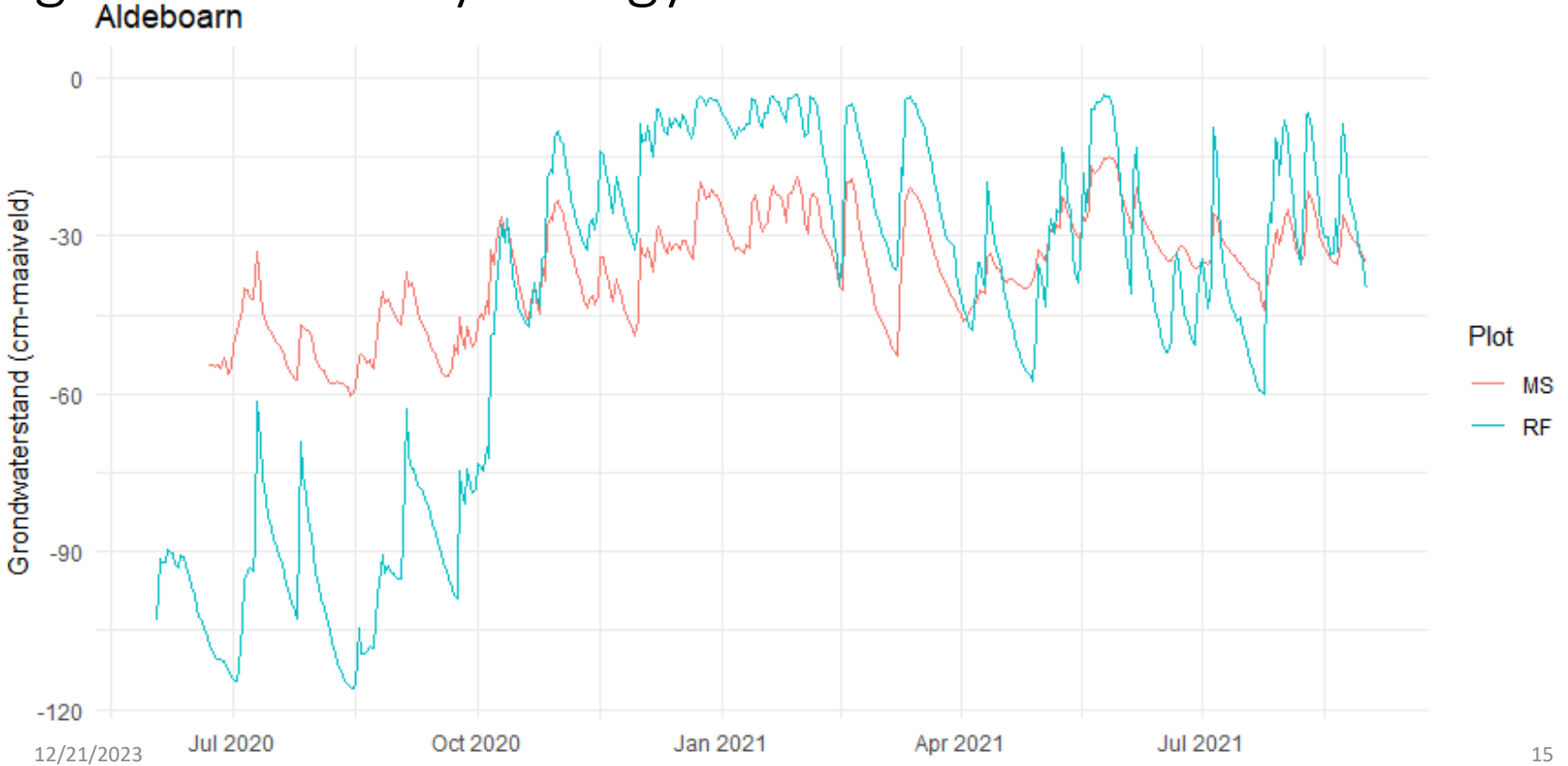
- chambers reference
- walking path
- no go area
- 220 cable -60 cm.
- Eddy Covariance station
- 2 meteo humidity/temp/baro/wind/rain meteo LW/SW/PAR/NIR in/out
- meteo heatflux
- rain
- soilmoisture + temp
- redox
- waterlevel NOBV
- waterlevel not NOBV
- biochemical sampling /pore water
- Hobo temp logger (hand data)
- datalogger
- PS power station 220V + 12 V DC
- SP solar panels
- 220 Liander 220 V. entry area



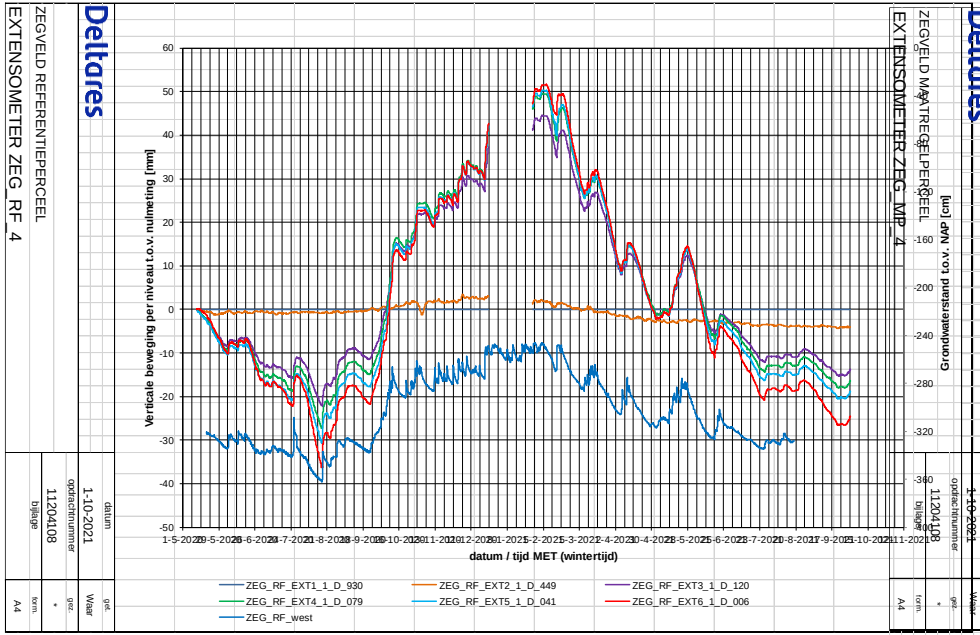
Location manager: Julia Land (RU)
Owner: Maatschap W.J.B. Kemp
Adress: Herenweg Ankeveen
Phone numbers:
Tom Heuts: 06 37315471
Tim (Waternet): 06 20522018

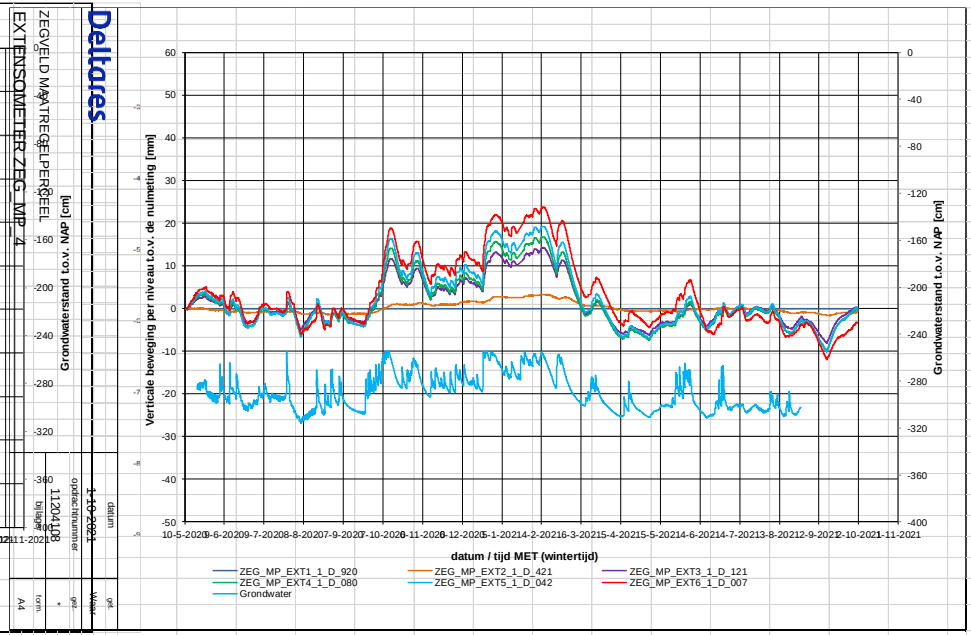
Date 15-11-2021 version 1

Impact measure (submerged drainage) on groundwater hydrology



Impact pressurised drainage system on surface elevation dynamics

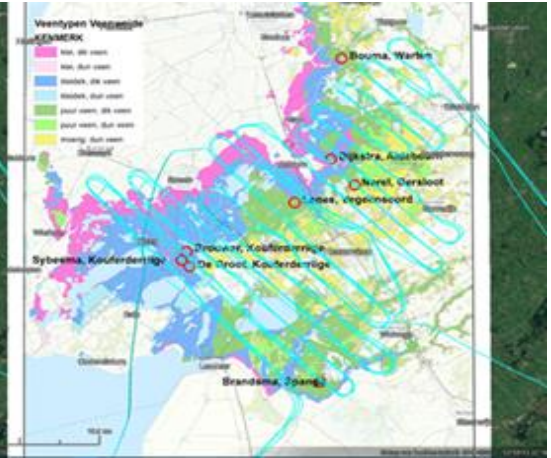


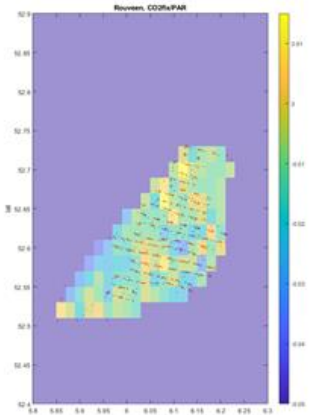


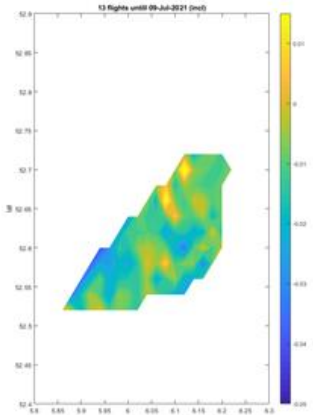
Impact measure on CO_2 emissions

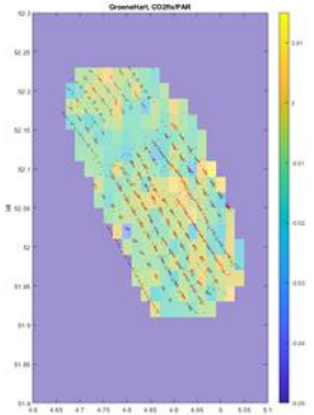
Location	Treatment	NEE	Harvest	C-input manure	Net flux
ALD EC	RF	8,6	15,3	-7*	16,9
	MS	10,7	13,2	-7*	16,9
ALD KA	RF+MS	15,8	18.0	-6,2	27,6
ASD KA	RF	-16,4	31,7	n.v.t.	15,3
	MP	-21,7	24,2	n.v.t.	2,6
ROU KA	RF+MP	9,2	18,3	n.v.t.	27,5
VLI KA	RF	-5,4	27,4	n.v.t.	21,9
	MS	-11,5	25,7	n.v.t.	14,2
ZEG EC	PT	5,5	11,4	onbekend	16,9

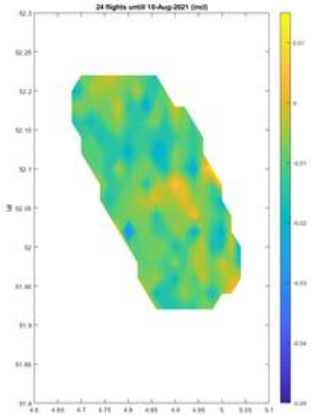
But also airborne measurements

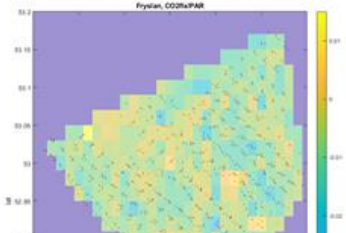


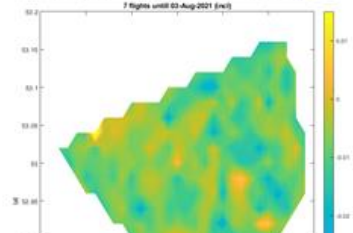






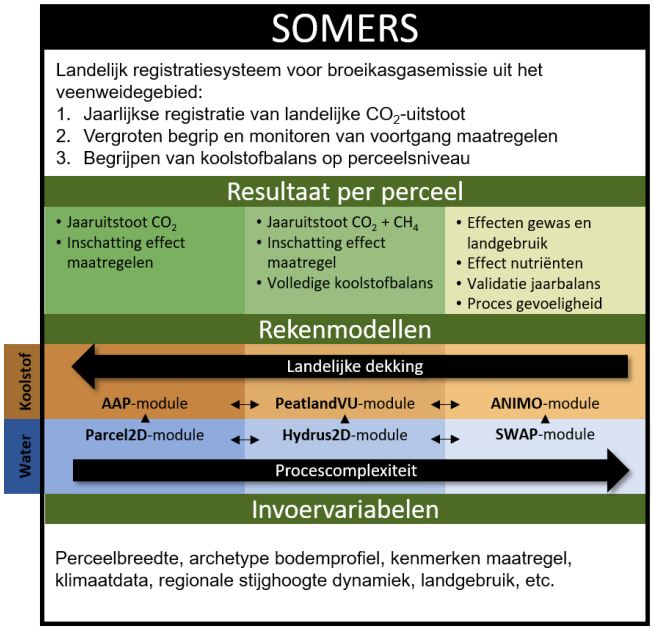


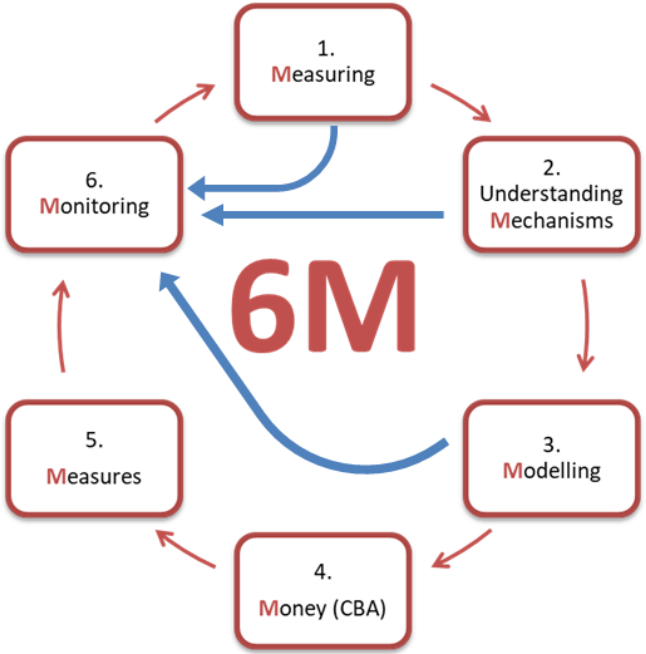




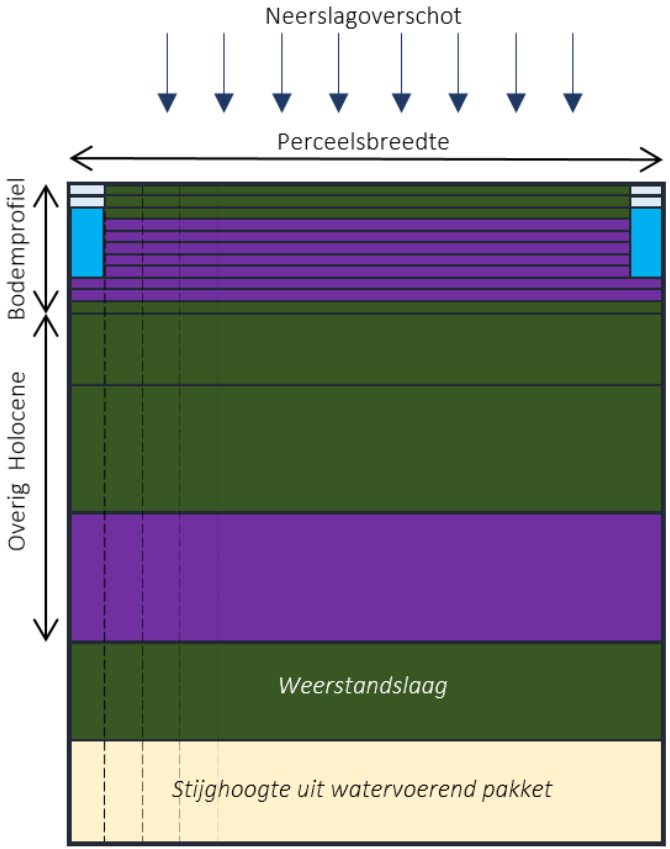
Monitoring with SOMERS

SOMERS: Subsurface Organic Matter Emission Registration System





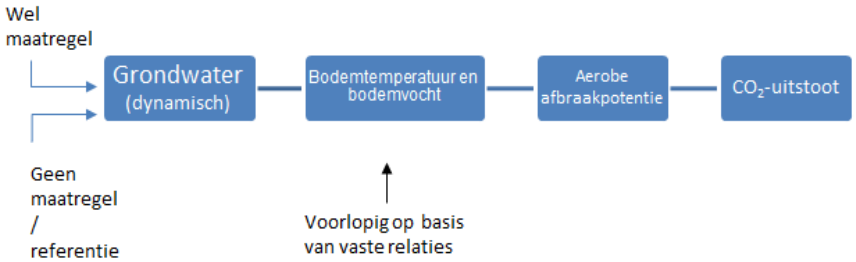
Monitoring on parcel level

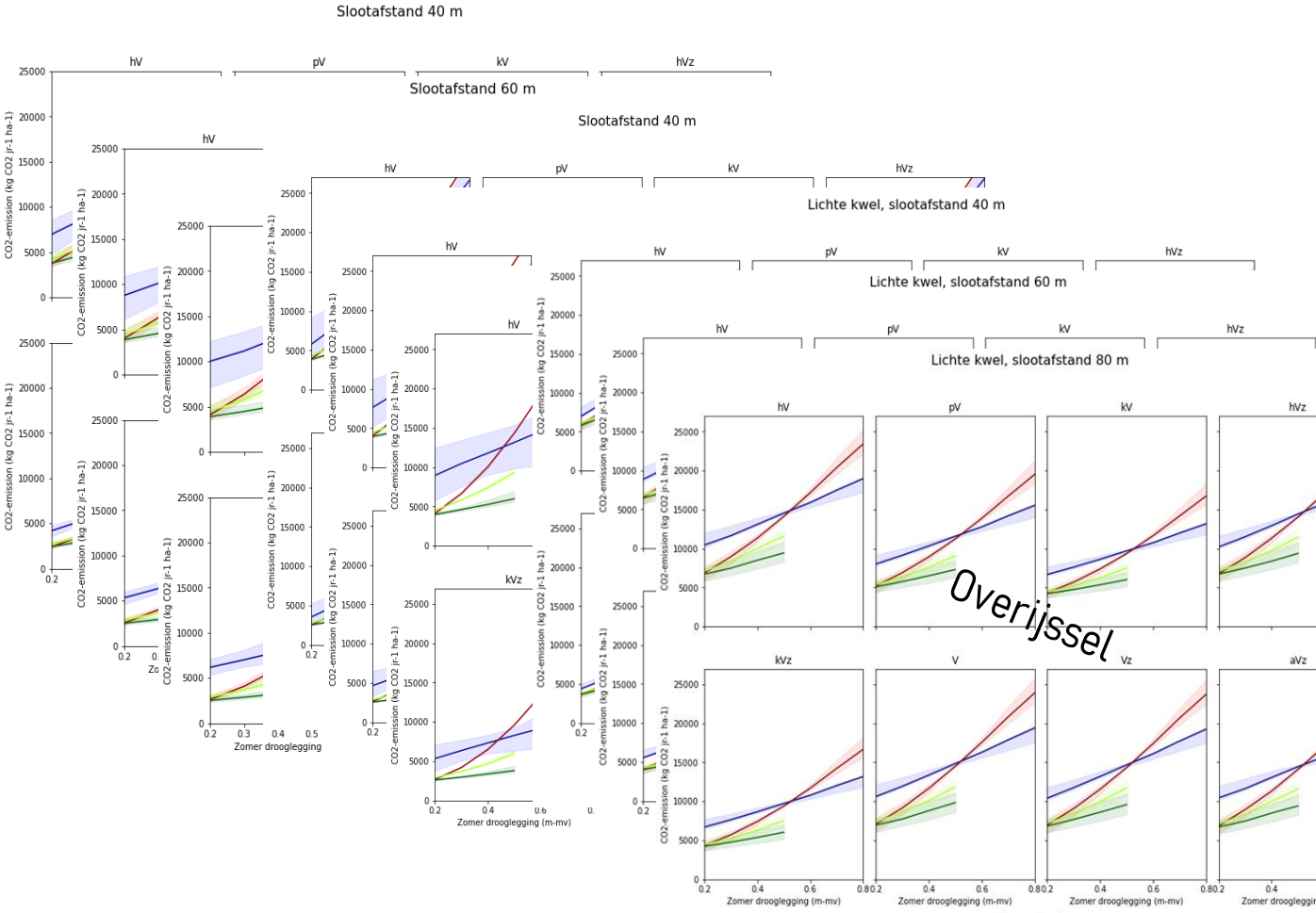


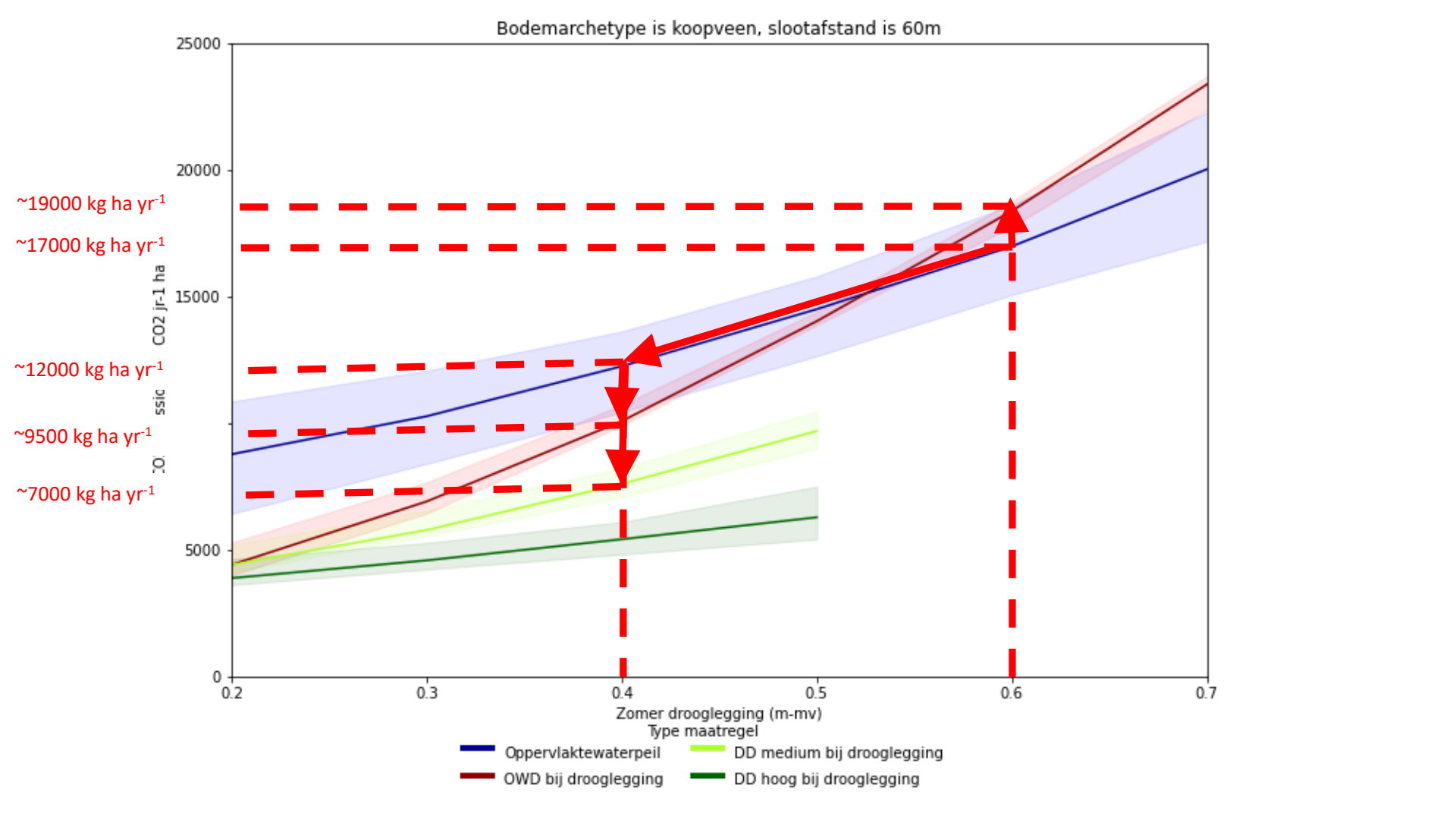
Parameter space

Impacting factors on GHG emissions (and land subsidence)

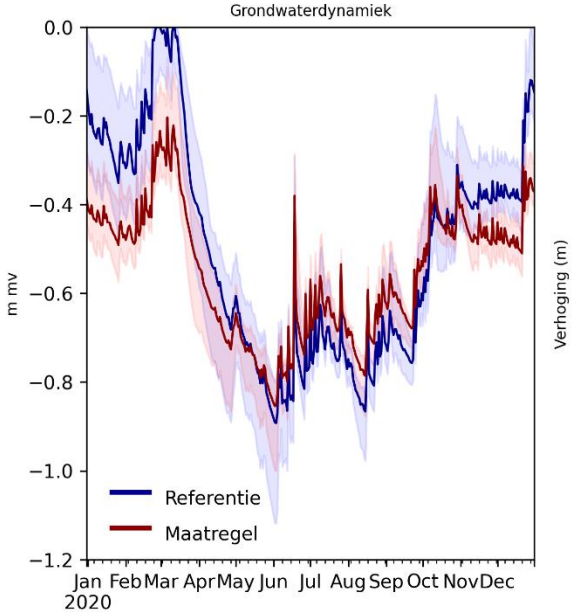
- Groundwaterlevel
  - Ditch water level
  - Parcel width (incl dry ditches)
  - Seepage/infiltration
- Deeper subsurface build up
  - Total peat thickness
  - Total thickness soft layers (only for land subsidence)
- Thickness of mineral layer at the surface
- Peat type (oligotrophic vs meso-/eutrophic)
- pH
- Management
  - Manure addition
  - Vegetation

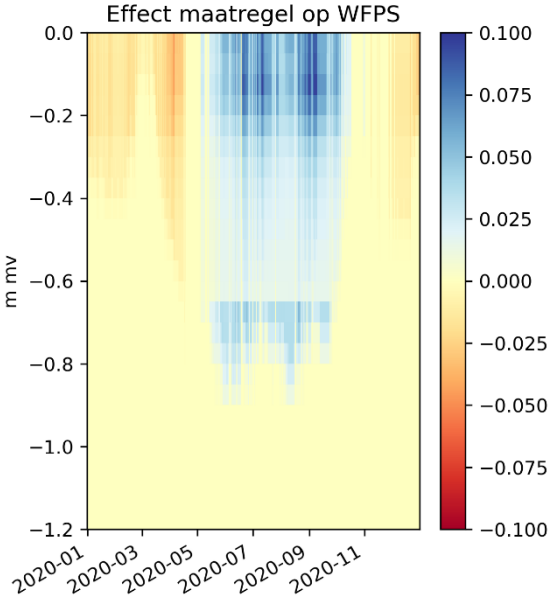


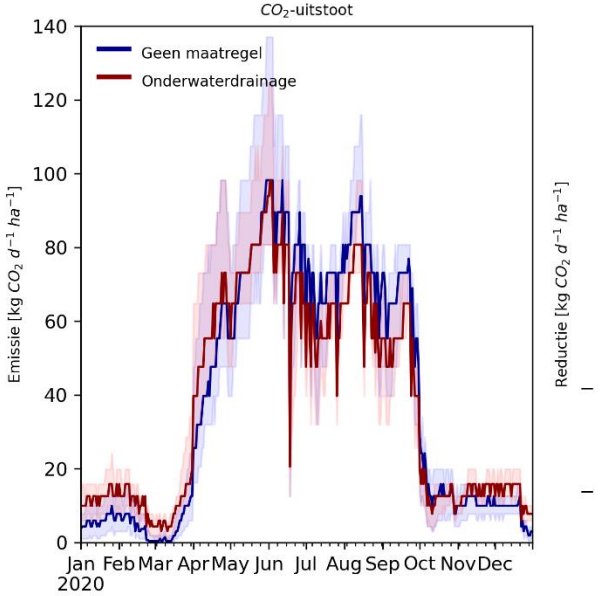

Slootafstand 40 m
hV
pV
kV
hVz
Slootafstand 60 m
Slootafstand 40 m
Lichte kwel, slootafstand 40 m
Lichte kwel, slootafstand 60 m
Lichte kwel, slootafstand 80 m
kVz
V
Vz
aVz
CO2-emission (kg CO2 jr-1 ha-1)
Zomer drooglegging
Zomer drooglegging (m-mv)
Overijssel


Bodemarchetype is koopveen, slootafstand is 60m
~19000 kg ha yr-1
~17000 kg ha yr-1
~12000 kg ha yr-1
~9500 kg ha yr-1
~7000 kg ha yr-1
CO2 jr-1 ha
25000
20000
15000
5000
0
0.2
0.3
0.4
0.5
0.6
0.7
Zomer drooglegging (m-mv)
Type maatregel
Oppervlaktewaterpeil
OWD bij drooglegging
DD medium bij drooglegging
DD hoog bij drooglegging

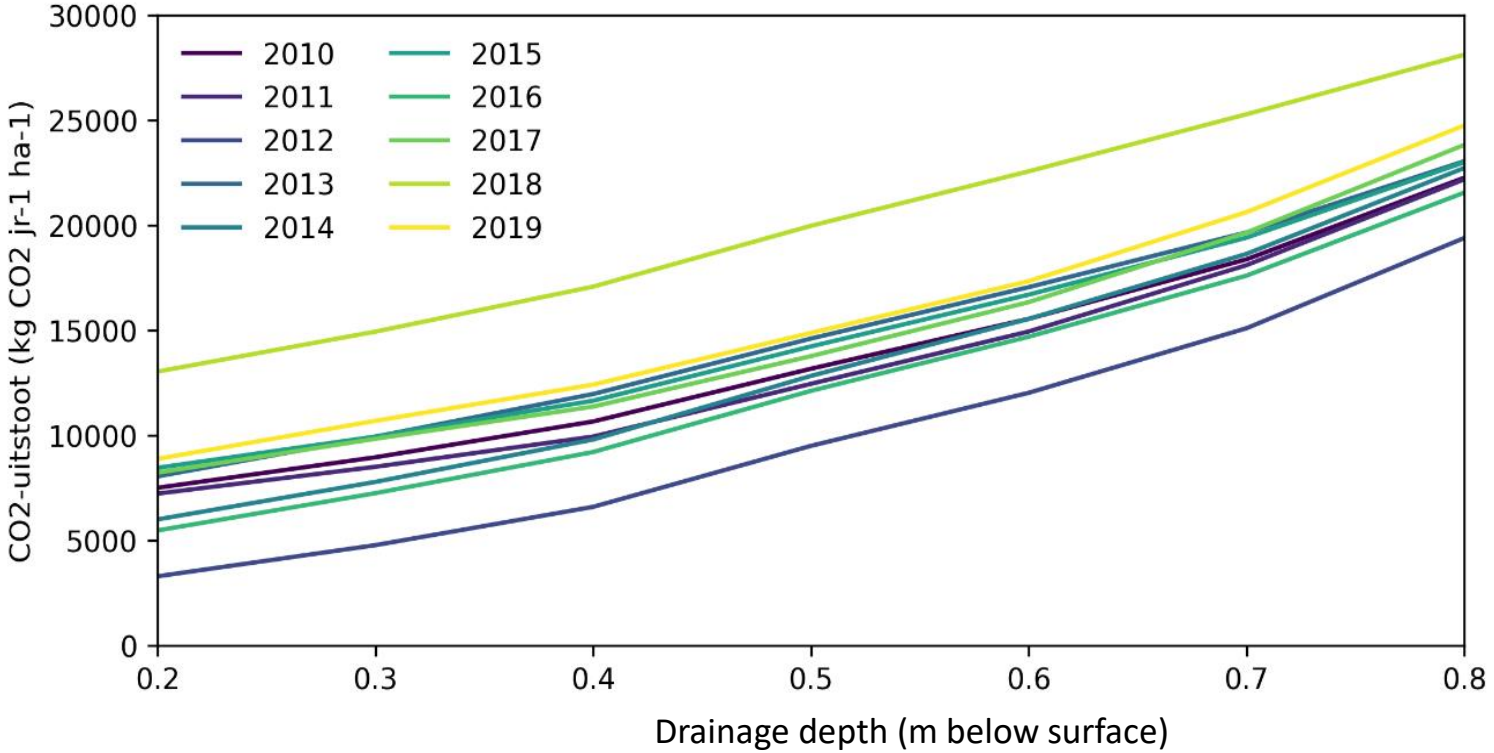
Three steps to daily, 5-cm interval, emissions







SOMERS Monitoring per year



Figuur 4.7: Gemodelleerde CO2-uitstoot voor verschillende drooglegginggssituaties en jaren.

Outlook

- Extending measurements to further include CH_4 and N_2O
- Installing new measurement sites: under wetter conditions, but also on minerals soils
- Improving numerical models based on process-understanding
- Investing in validation sites and empirical relations
- In 2 years time….delivering on results to support policy development

A NATIONAL RESEARCH PROGRAMME ON GREENHOUSE GAS EMISSIONS AND LAND SUBSIDENCE FROM LOWLAND PEAT IN THE NETHERLANDS

Nationaal Onderzoeksprogramma Broeikasgassen Veenweiden

stowa Deltares

vrije Universiteit

Radboud Universiteit Nijmegen

WAGENINGEN UNIVERSITY & RESEARCH

Universiteit Utrecht

ONDERZOEKCENTRUM B ware

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Flevo Instruments

TU Delft Delft University of Technology

Photo by Eline Hoftiezer