# Subsidence and $CO_2$ emissions of Dutch peat soils in agricultural use and submerged drains infiltration to diminish peat oxidation

Jan van den Akker, Rob Hendriks, Idse Hoving, Matheijs Pleijter

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## Where to find:

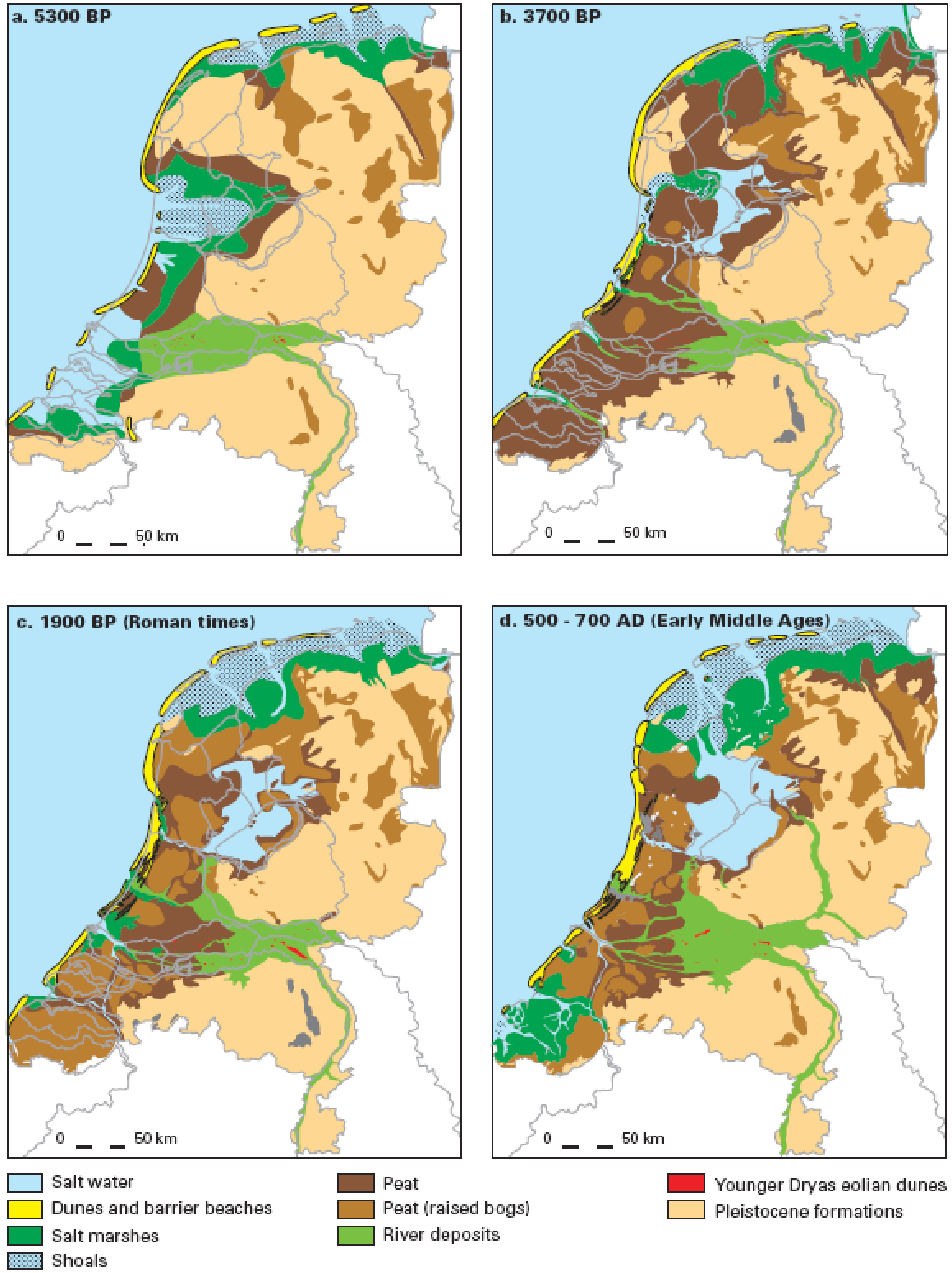
- Van den Akker et al., 2015. Decline in organic matter in peat soils. In: *Stolte et al., 2015. Soil in Europe: Threats, functions and ecosystem services.* JRC – report.
- http://eusoils.jrc.ec.europa.eu/
- http://www.recare-project.eu/

- www.ti.bund.de/caos

# Outline

- Introduction
- Subsidence of peat soils in The Netherlands
- From subsidence => $CO_2$ emission
- Minimizing by infiltration via submerged drains
- Conclusions

# Peat Before Present (BP)

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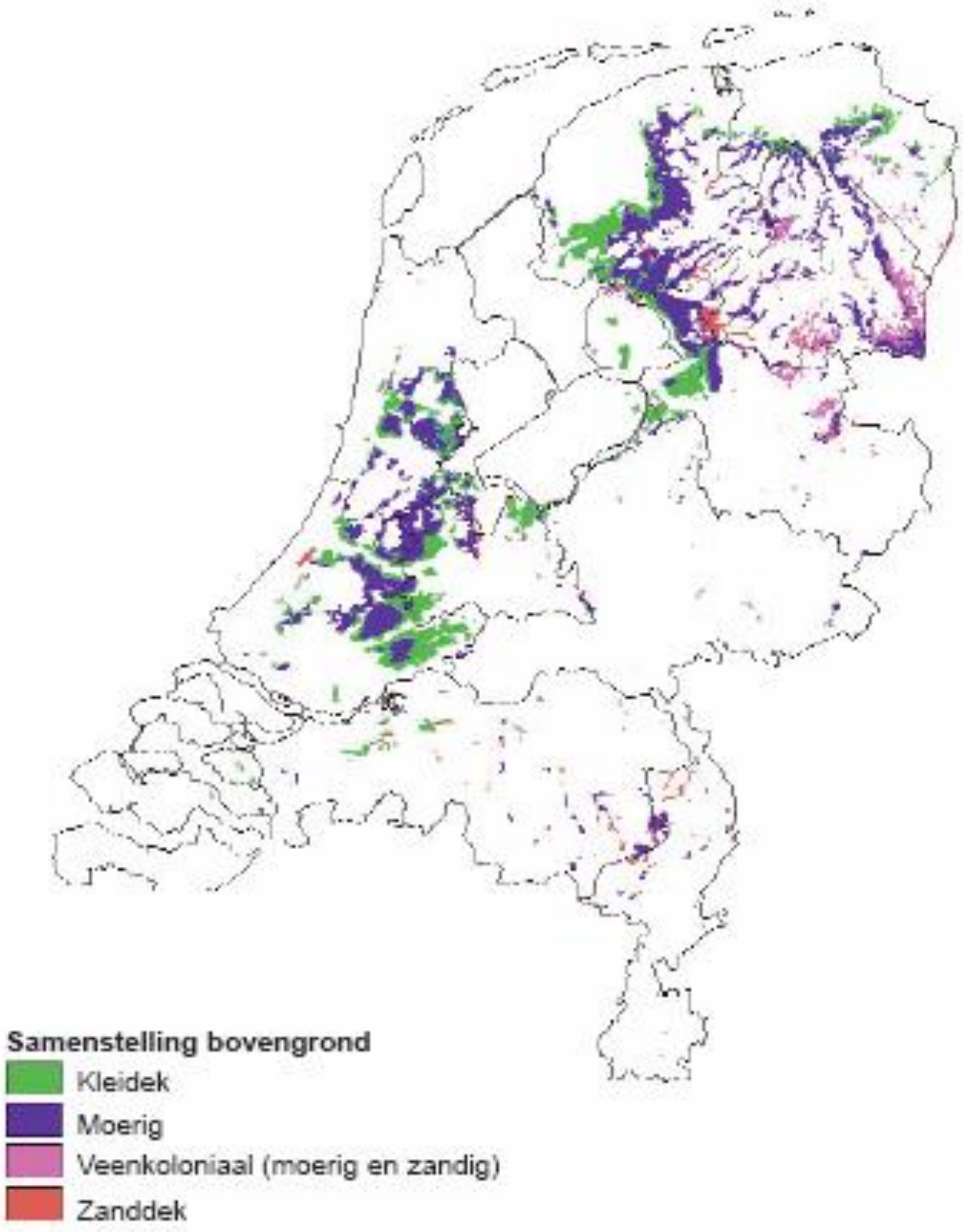
**Peat soils in The Netherlands**

| | |
|---|---|
| Agriculture | 220,000 ha |
| Nature | 35,000 ha |
| Other | 35.000 ha |
| Total | 290,000 ha |

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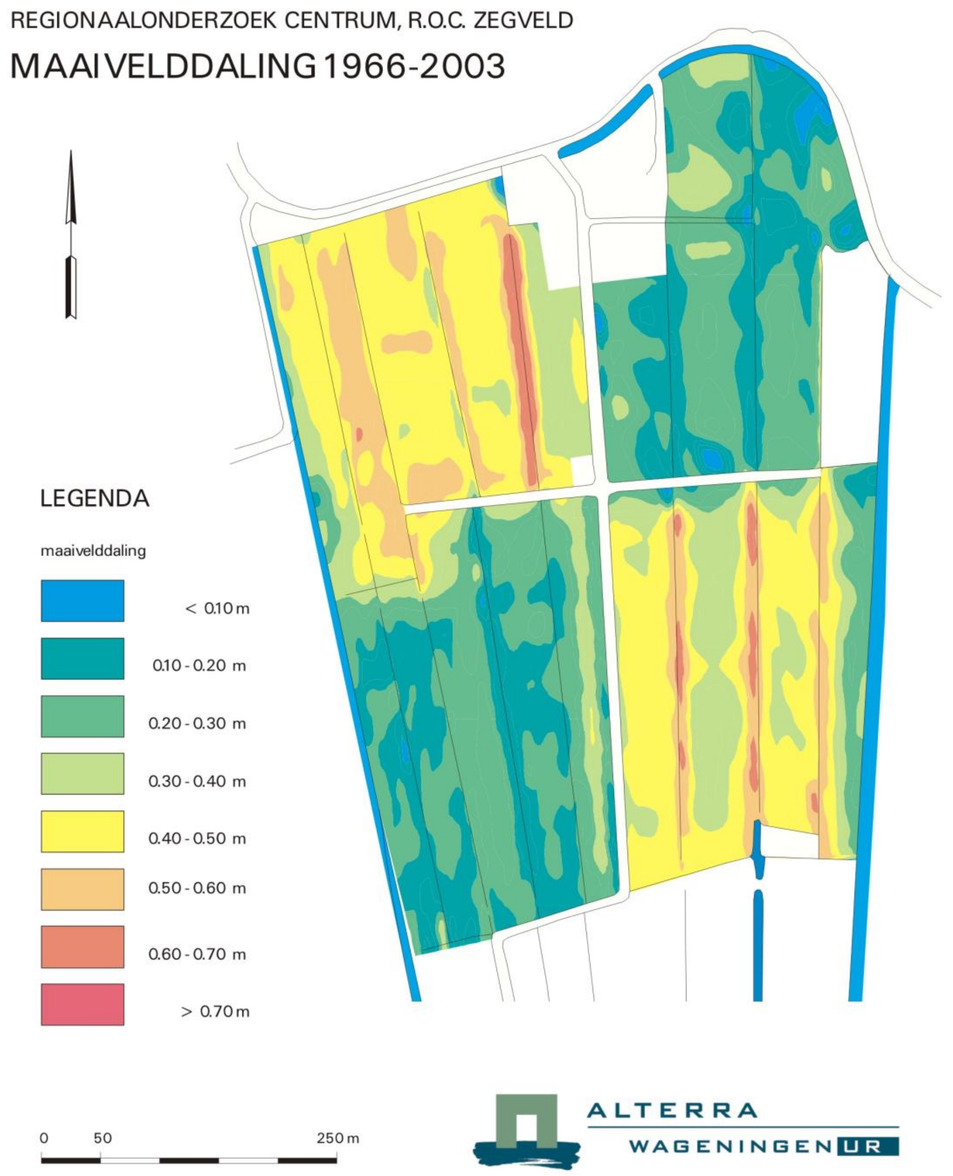
# Problem: Degradation of peat soils by oxidation

- Subsidence (NL: 0 – 2.5 cm per year)
- Damage to buildings and infra structure
- Increasing costs of water management
- Drainage of nature reserves to lowered agricultural land
- Water pollution
- Green House Gas emissions (NL: 2 – 3 % total $CO_2$)
- Loss of peat soils (NL: 2 % per year)

# Components subsidence

- Consolidation
- Shrinkage
- Oxidation => $CO_2$

1 mm subsidence = 2.26 t $CO_2$ per ha

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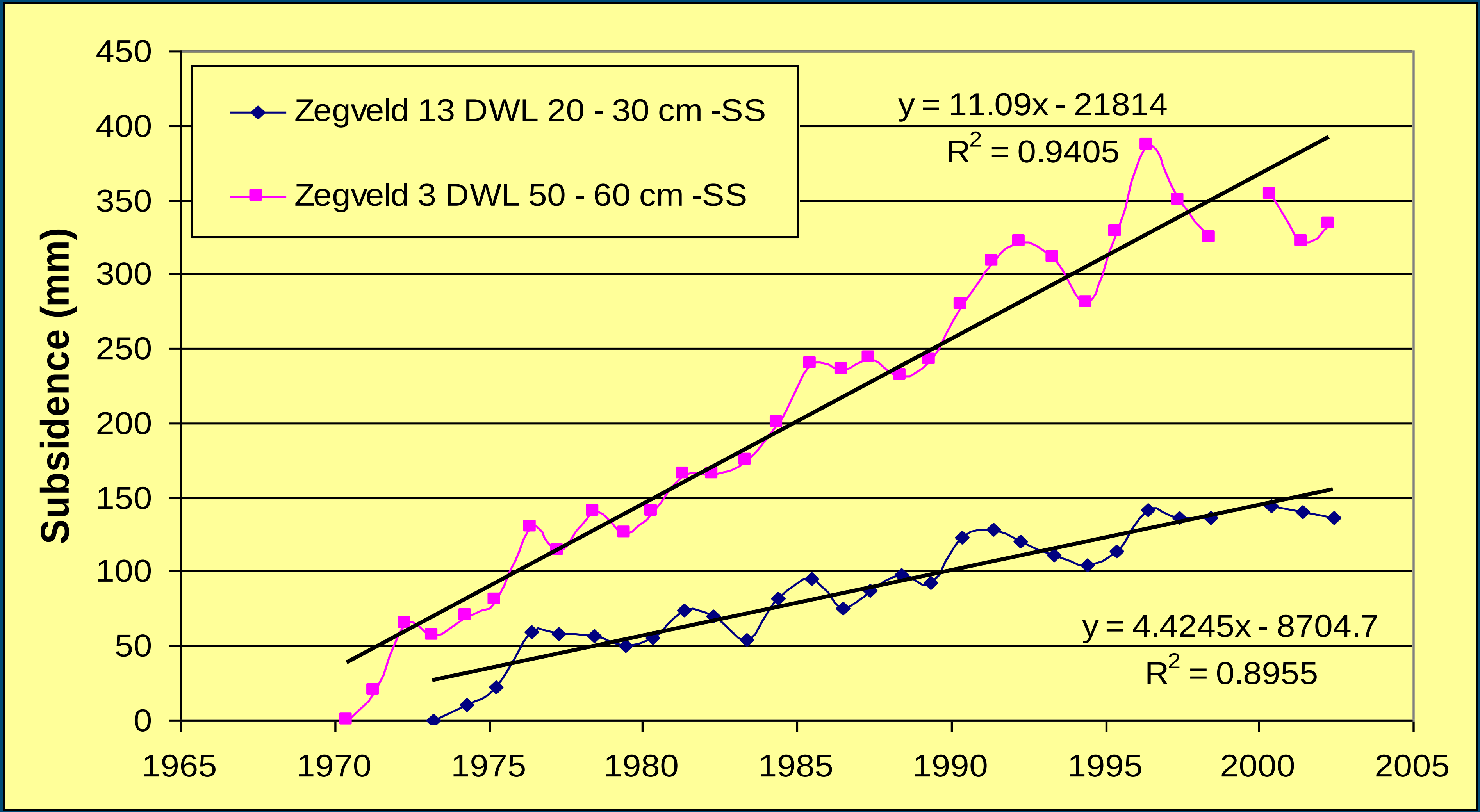
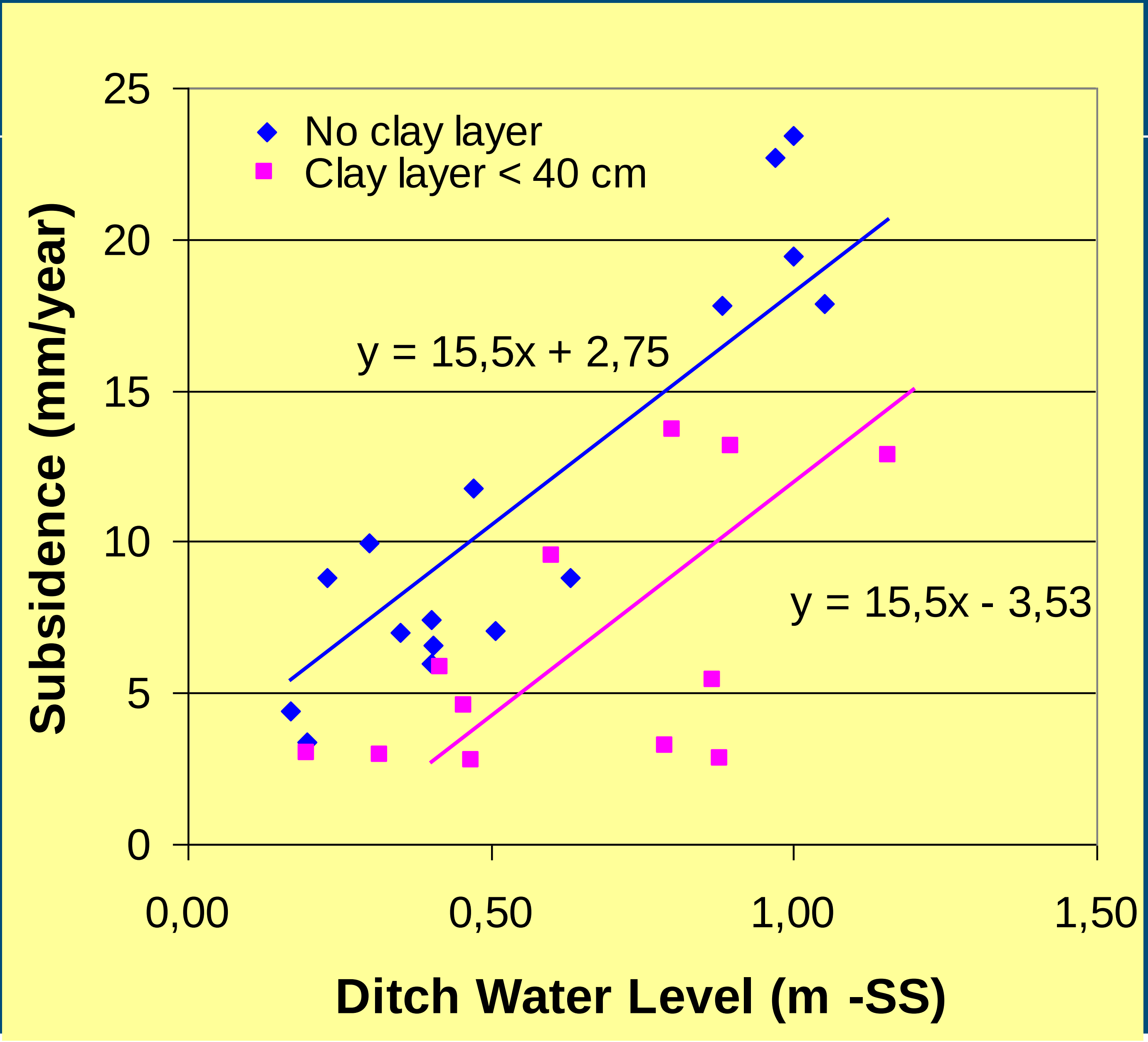
# Subsidence in relation to Ditch Water Level



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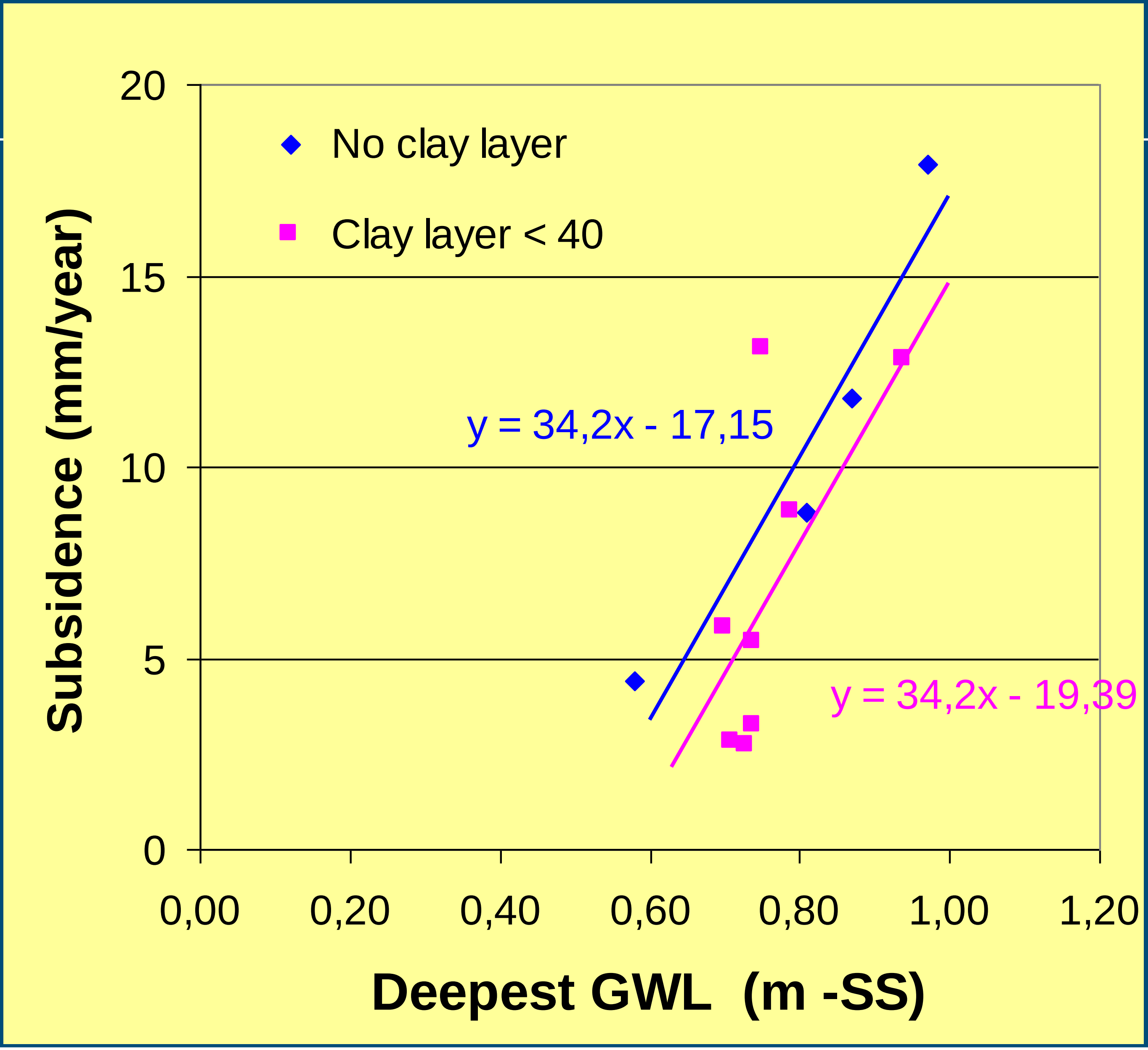


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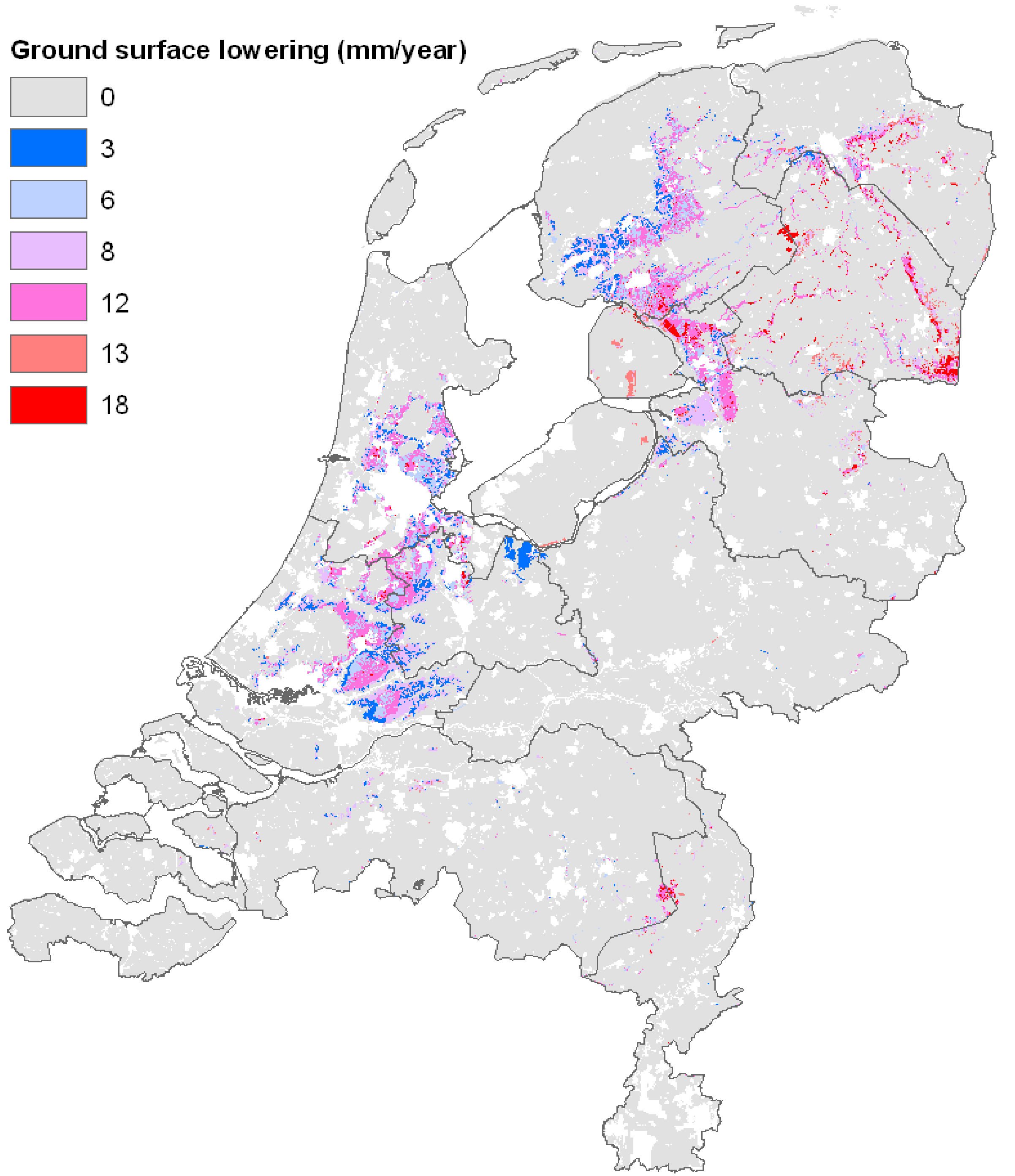
Subsidence peat soils calculated from mean deepest groundwater levels (mm/year)

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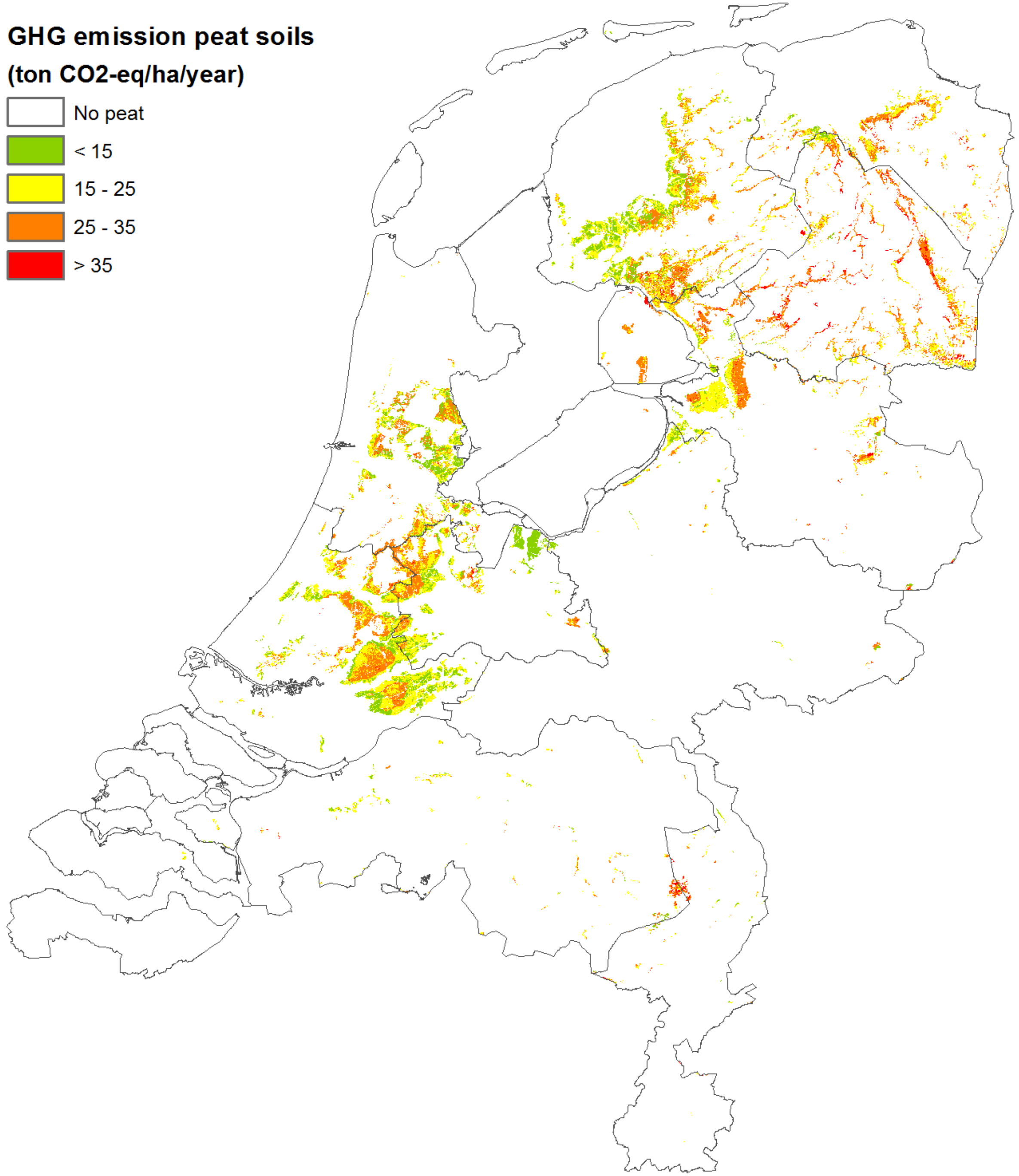
# $CO_2$-eq emission peat soils (ton $CO_2$-eq per year)



# $CO_2$ and $N_2O$ emissions Netherlands in $CO_2$ eq

| $CO_2$ equivalents | Emission in Mton $CO_2$ |
| --- | --- |
| $CO_2$ | 4.24 |
| $N_2O$ | 0.51 |
| Total | 4.76 |

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| Country | Agricultural area km² | Crop area km² | Grass area km² | $CO_2$ - C Mt / a | $CO_2$ Mt / a | $N_2O$ $CO_2$ eq Mt / a | Total $CO_2$ eq Mt / a |
|---|---|---|---|---|---|---|---|
| *Member states of the EU* | | | | | | | |
| Belgium | 252 | 25 | 227 | 0.15 | 0.55 | 0.05 | 0.60 |
| Denmark | 184 | 0 | 184 | 0.10 | 0.37 | 0.03 | 0.40 |
| Estonia | 840 | 0 | 840 | 0.46 | 1.68 | 0.14 | 1.82 |
| Finland | 2930 | 0 | 2930 | 1.60 | 5.86 | 0.49 | 6.35 |
| Germany | 14133 | 4947 | 9186 | 10.41 | 38.16 | 3.18 | 41.33 |
| Ireland | 2136 [a] | 896 | 1240 | 1.65 | 6.06 | 0.50 | 6.57 |
| Italy | 90 | 90 | 0 | 0.10 | 0.36 | 0.03 | 0.39 |
| Latvia | 1000 [a] | 1000 | 0 | 1.09 | 4.00 | 0.33 | 4.33 |
| Lithuania | 1900 [b] | 1357 | 543 | 1.78 | 6.51 | 0.54 | 7.06 |
| Netherlands | 2050 [c] | 75 | 1975 | 1.16 | 4.25 | 0.35 | 4.60 |
| Poland | 7600 | 55 | 7545 | 4.18 | 15.31 | 1.27 | 16.58 |
| Sweden | 2500 [d] | 630 | 1870 | 1.71 | 6.26 | 0.52 | 6.78 |
| UK | 392 | 392 | 0 | 0.43 | 1.57 | 0.13 | 1.70 |
| Total EU | 36007 | 9467 | 26540 | 24.80 | 90.95 | 7.57 | 98.51 |

Schils et al. 2008

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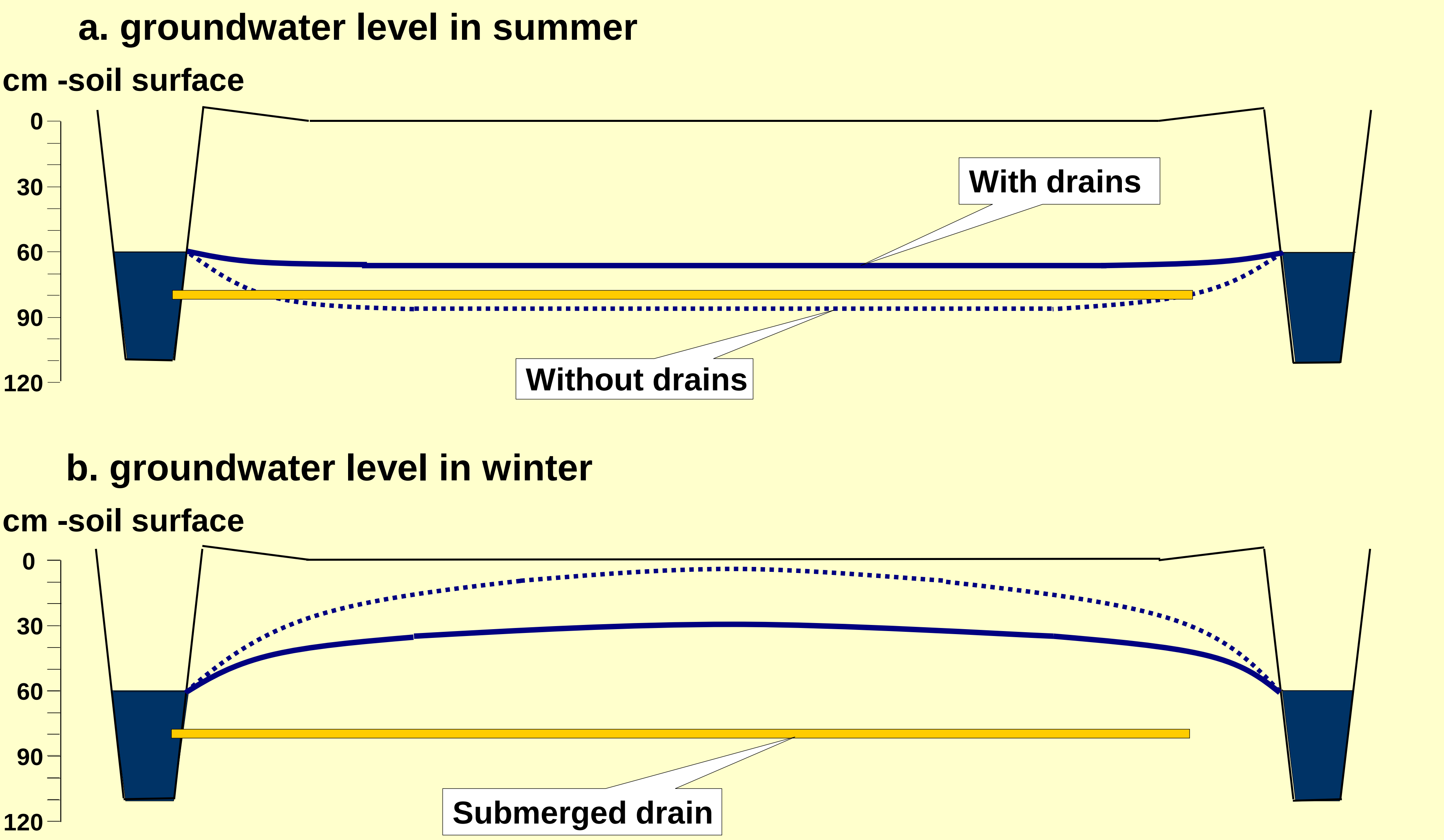
# Prevention by infiltration with submerged drains

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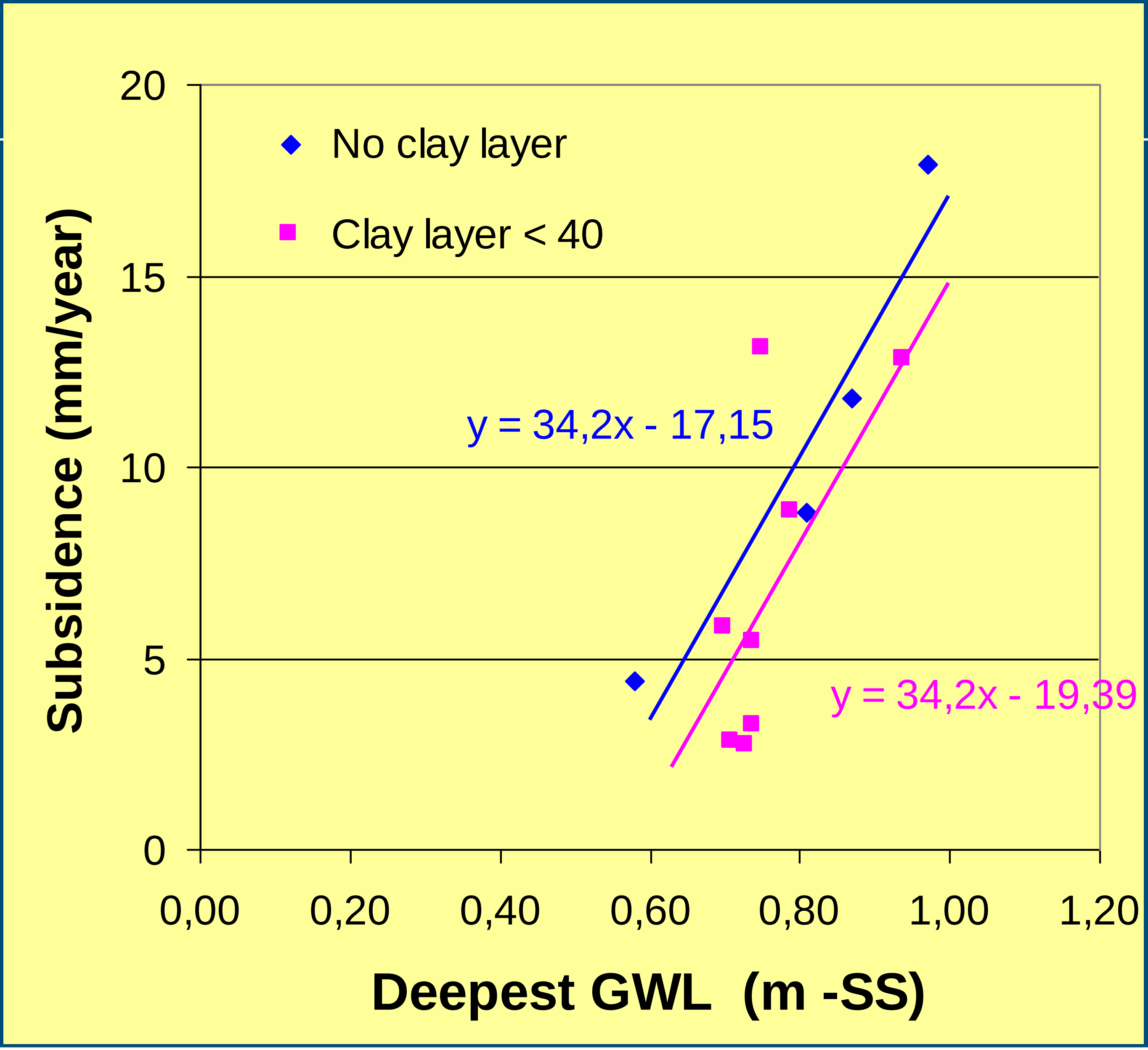


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# Installation submerged drains

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# Questions on effects of submerged drains about:

- Subsidence and $CO_2$ emissions
- Water quality (N, P and $SO_4$)
- Water quantity (inlet and pumping out)
- Water management infrastructure
- Meadow birds
- Dairy farming (costs, yields, etc)

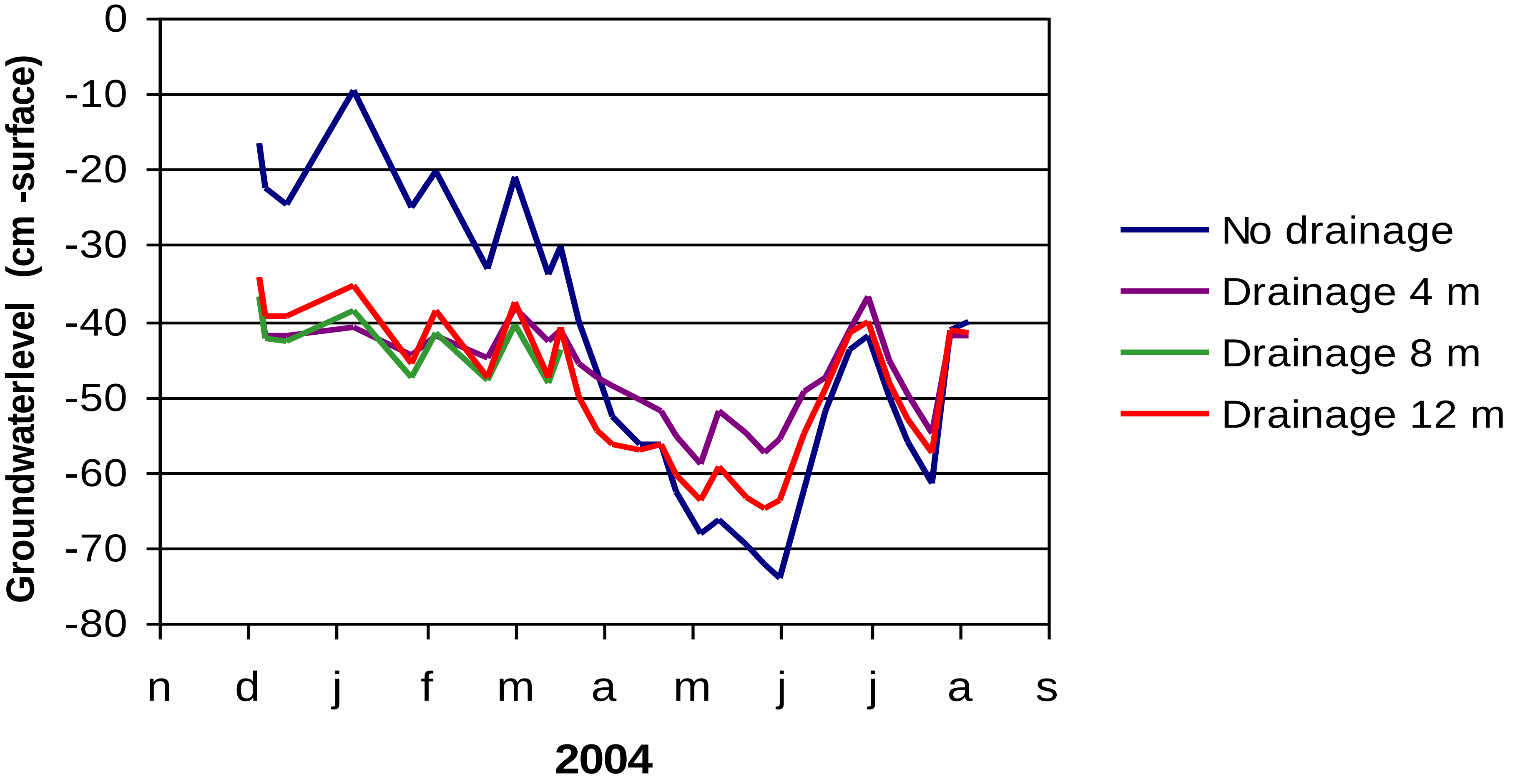
# Field experiment Zegveld

Period: 2004 - 2009

Treatments:

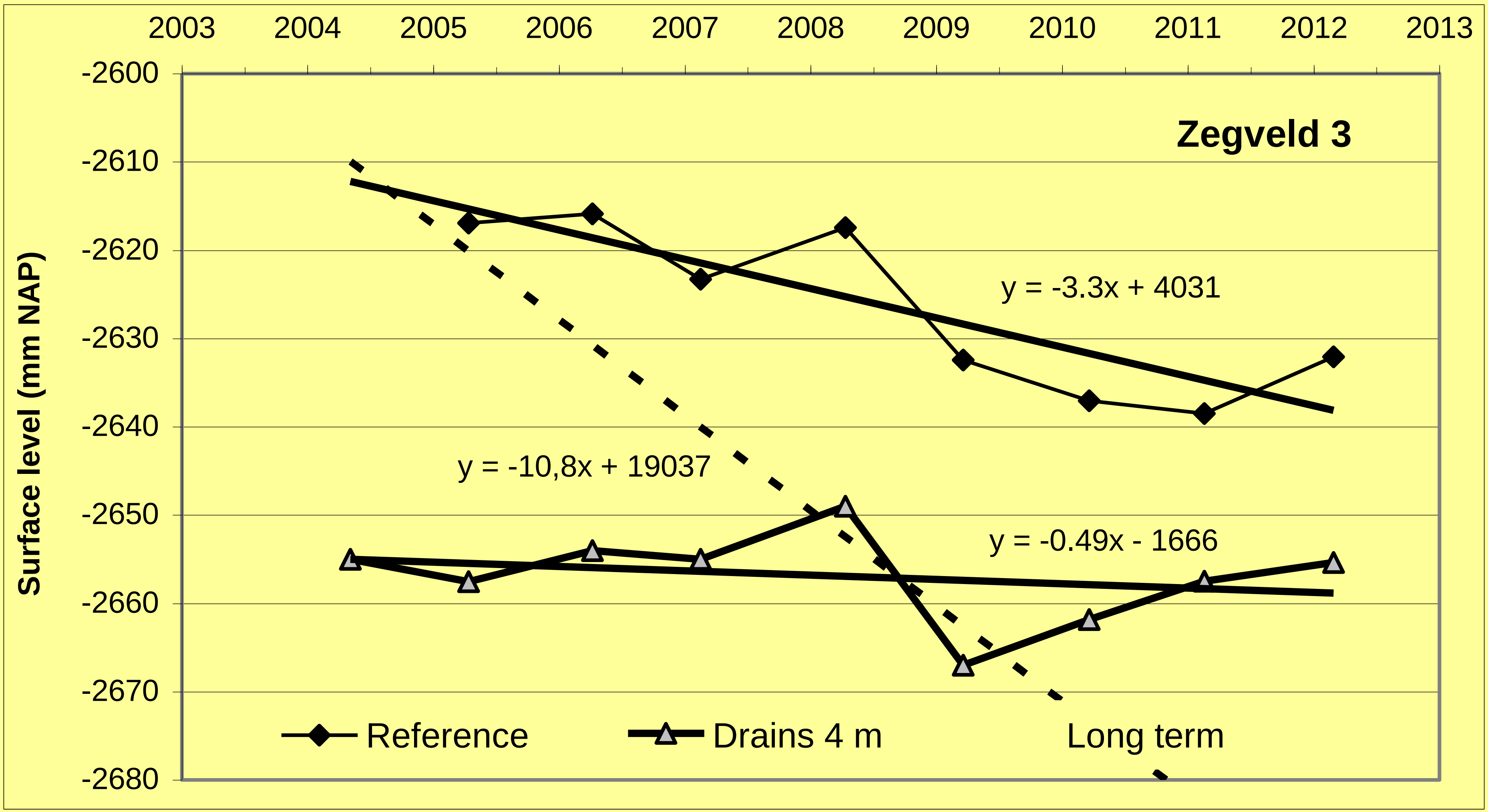
- High (20 cm –surface) and low (55 cm -surface) ditchwater level
- Tube drainage diameter 6 cm
- Drain distances: 4, 8 and 12 m

# Ditch water level 55 cm -surface



# Subsidence from 2004 on, Ditch Water Level = 55 cm:

## We “guarantee” 50% reduction of subsidence and so also CO2



# Water quality (N, P and $SO_4$

- In general water quality will (slightly) improve
- P allways positive
- N seldom slightly negative in case of upward seepage and thin clay cover
- $SO_4$ sometimes negative in case of freeboard 60 cm

# Water quantity (inlet and pumping out)

- Inlet will increase (reduction peat oxidation requires water!)
- By far more water efficient than raising ditchwater levels.
- Smart water management saves a lot of inlet water (water level margins of + / – 10 cm; use of wheather forecasting)
- Pumping out: a bit more
- Peak values (say 50 mm rain => -2 to 3 cm extra raise of ditchwater level)

# Some requirements of submerged drains:

- Highest ditchwater level farming: about 30/35 cm –soil surface
- Lowest ditchwater level: 60 cm –soil surface
- Drains about 15/20 cm –ditchwater level
- Minimum diameter 6 cm; then length < 300 m
- Distance between drains < 6 meters
- Good installation and maintainance is very important

# Meadow birds

- No effect on soil biota (a.o. wurms)
- Penetration resitance with 1 $cm^2$ increased, however, no significant difference in days with ‘weak’ soils
- No difference in flowering of the grass
- In general no significant difference between WITH and WITHOUT submerged drains

# Water management infrastructure

- Less problems with difference between subsiding soil surfaces and constant water levels in lakes and high water ditches (along houses)
- Less sub-polders with a certain fixed ditch water level
- Possibility to create areas with a high surface level (with submerged drains) and a low surface level (without SD)

# Dairy farming (costs, yields, etc)

- Costs installation all in € 1 / m drain; € 1700 – € 2500 / ha
- Live time: 20 – 30 years
- Significant extra days with ‘good’ bearing capacity
- Yield lower due to reduced mineralization of N
- Yield higher due to better usage of manure (better nutrients efficiency)
- Less trampling of grass
- Longer grazing season
- In total a higher effective yield
- Short term: slightly cost effective. Long term: good cost effective

# Conclusions

- Problems with subsidence, $CO_2$, water quality, etc will increase in time
- Climate change will double the problems
- Adaptation and minimizing peat oxidation is urgently needed
- A strong reduction of subsidence and GHG emissions is possible by using submerged drains
- Conservation of peat soils requires WATER
- Submerged drains are the most **water** efficiënt solution to conserve peat soils
- Submerged drains are also the most **cost** efficiënt solution

# Thank you for your attention