Water management in lowland peat soils

Prof Ian Holman and Dr Nick Girkin

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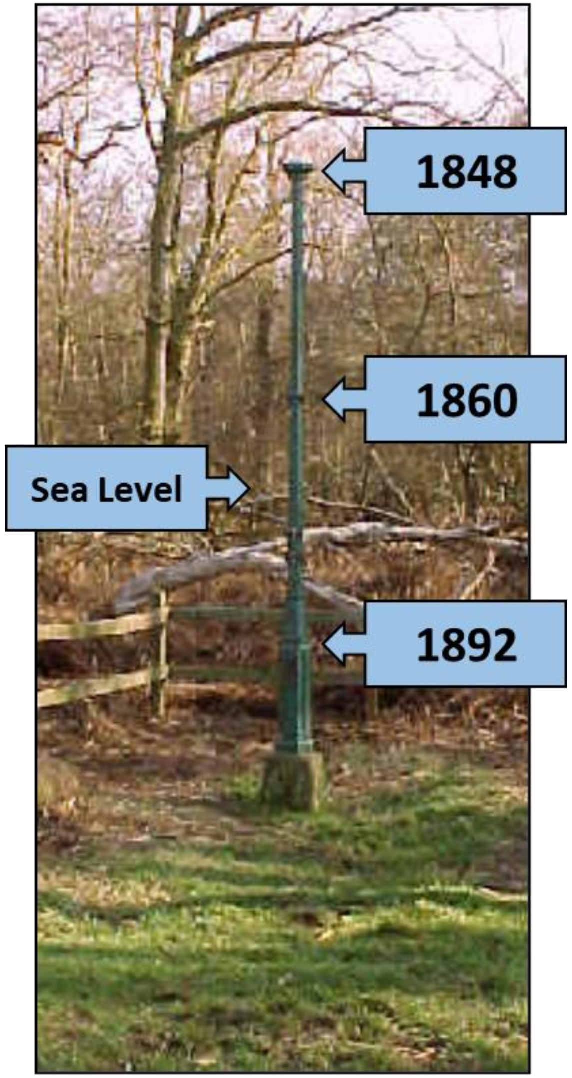
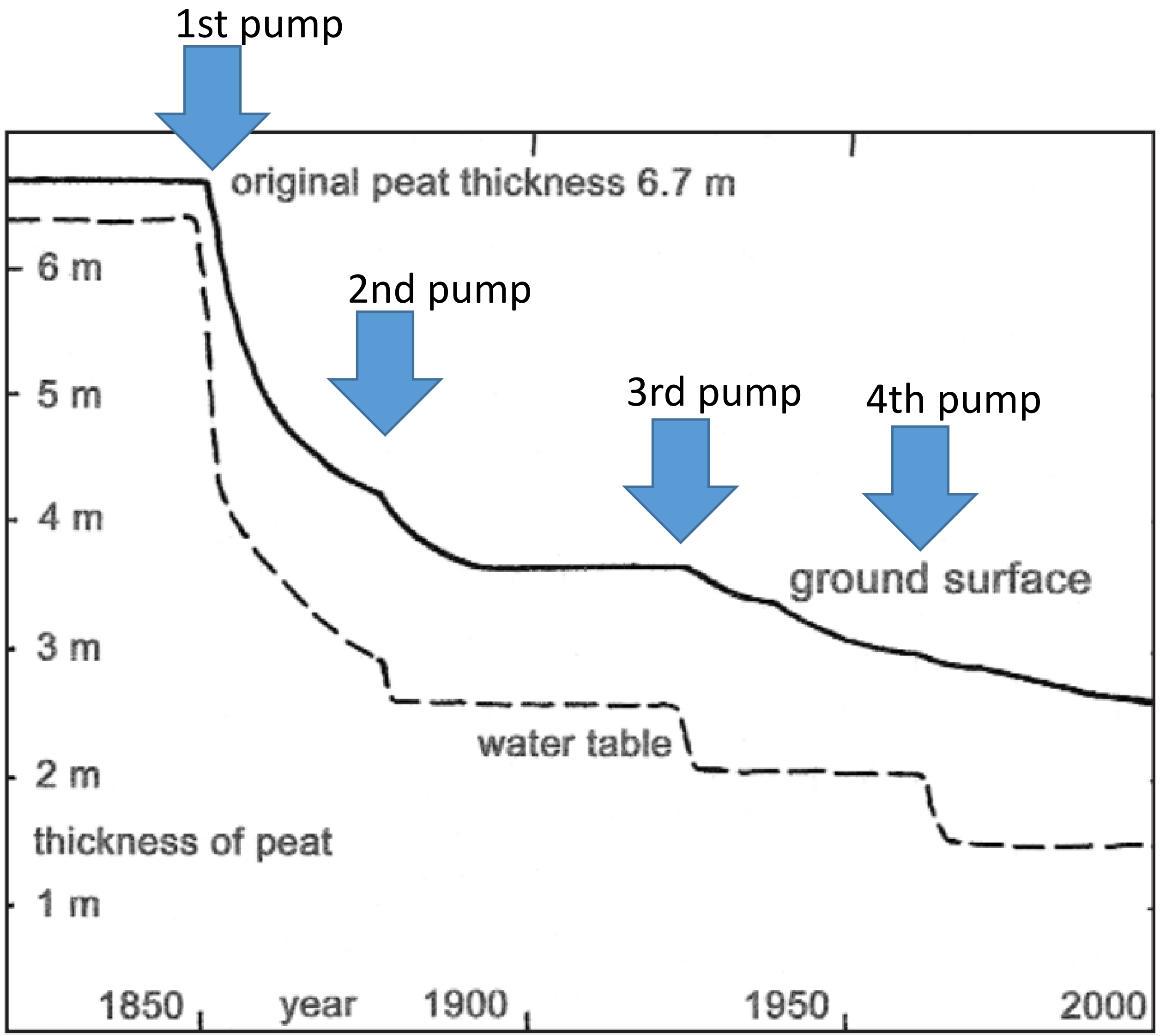
Overview

- Importance of water management for peatland management and GHG emissions
- Basics of land drainage for watertable control
- The challenge(s) of assessing in-field watertables
- Case study: deriving peatland GHG emissions in The Broads, UK
- Reducing emissions
- Conclusions

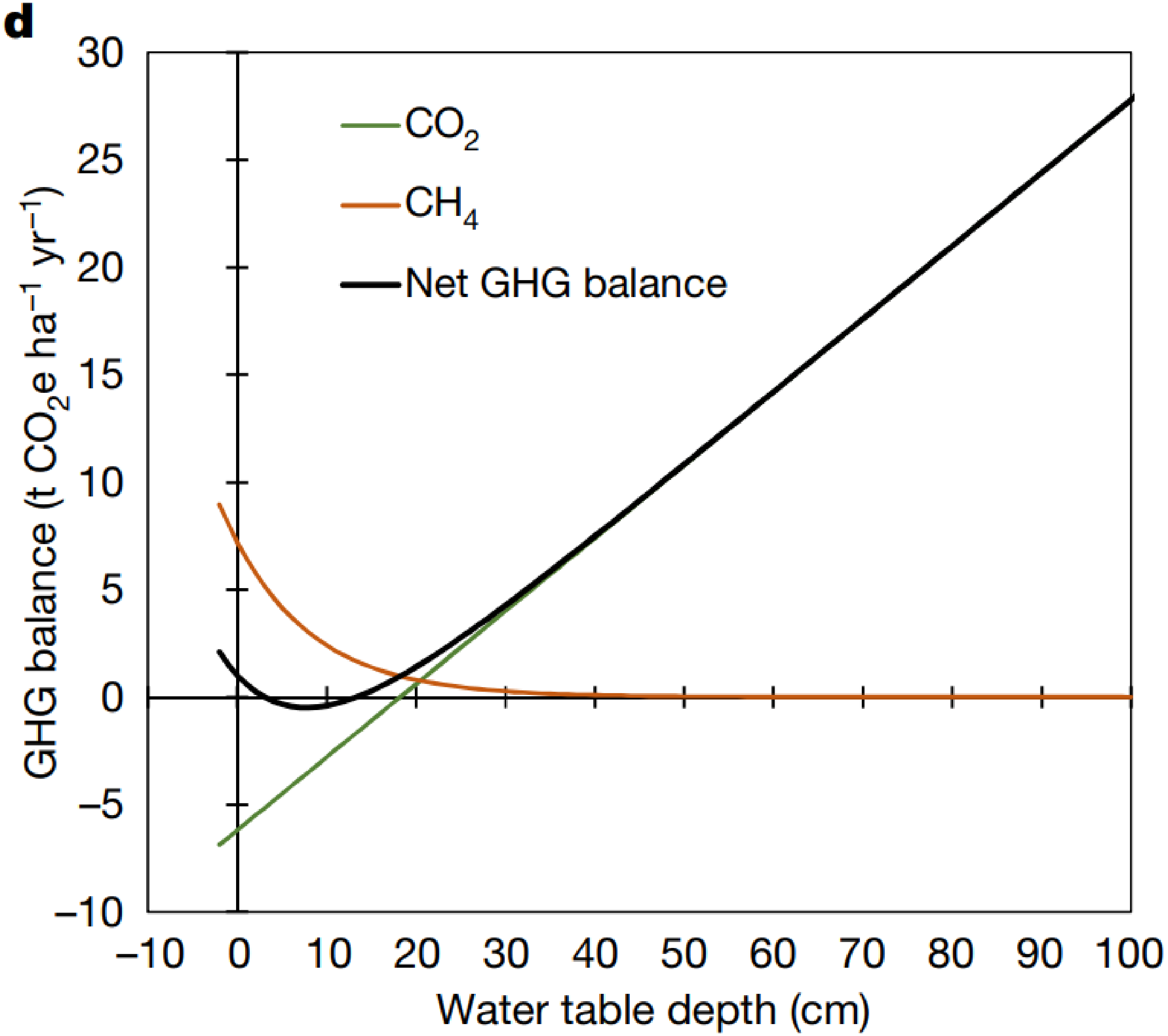
Importance of water management





Waltham (2000). Mercian Geologist 15(1): 49-51

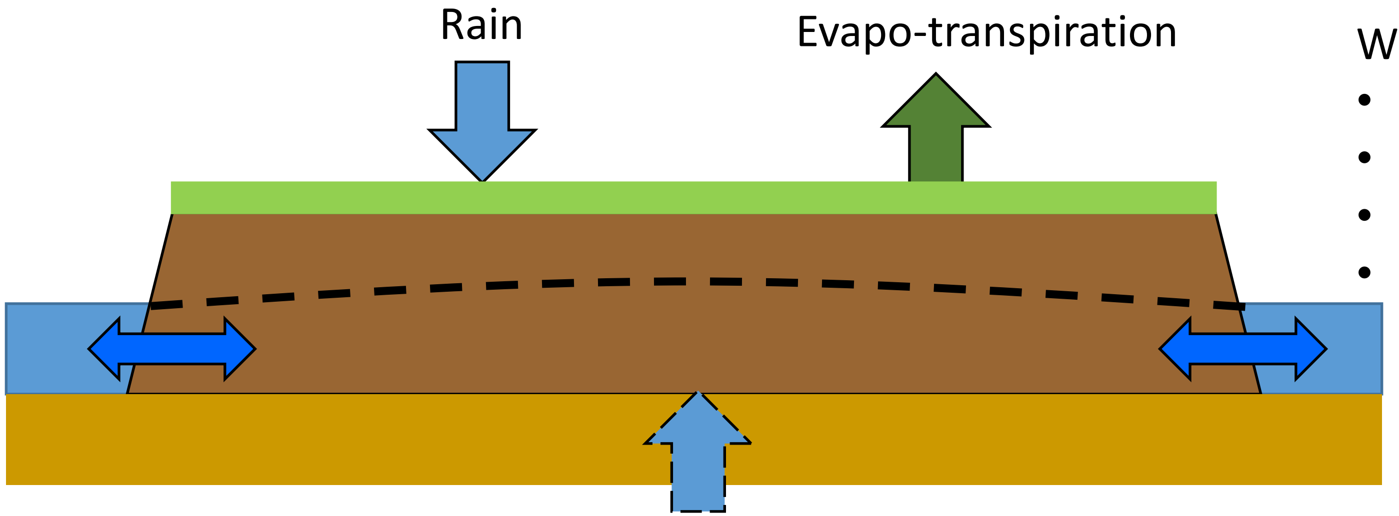
Importance of watertable management



Deeper in-field watertable = more GHG emissions

Evans et al. (2021). https://doi.org/10.1038/s41586-021-03523-1

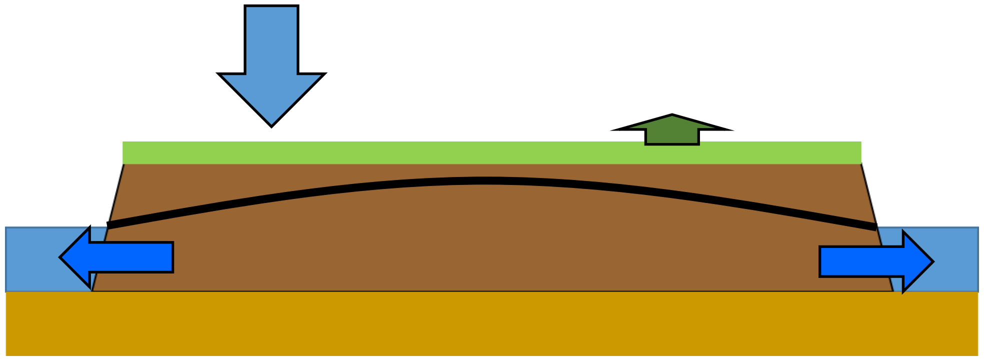
Basics of drainage



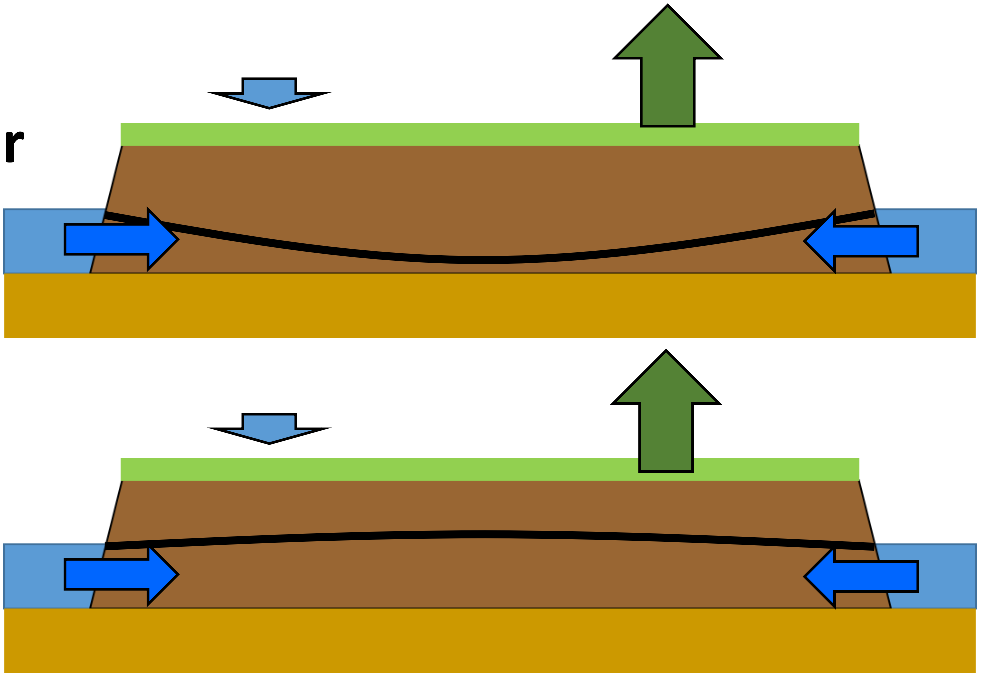
Watertable depth is function of:

- Weather
- Drain water level
- Soil properties
- Distance from drain

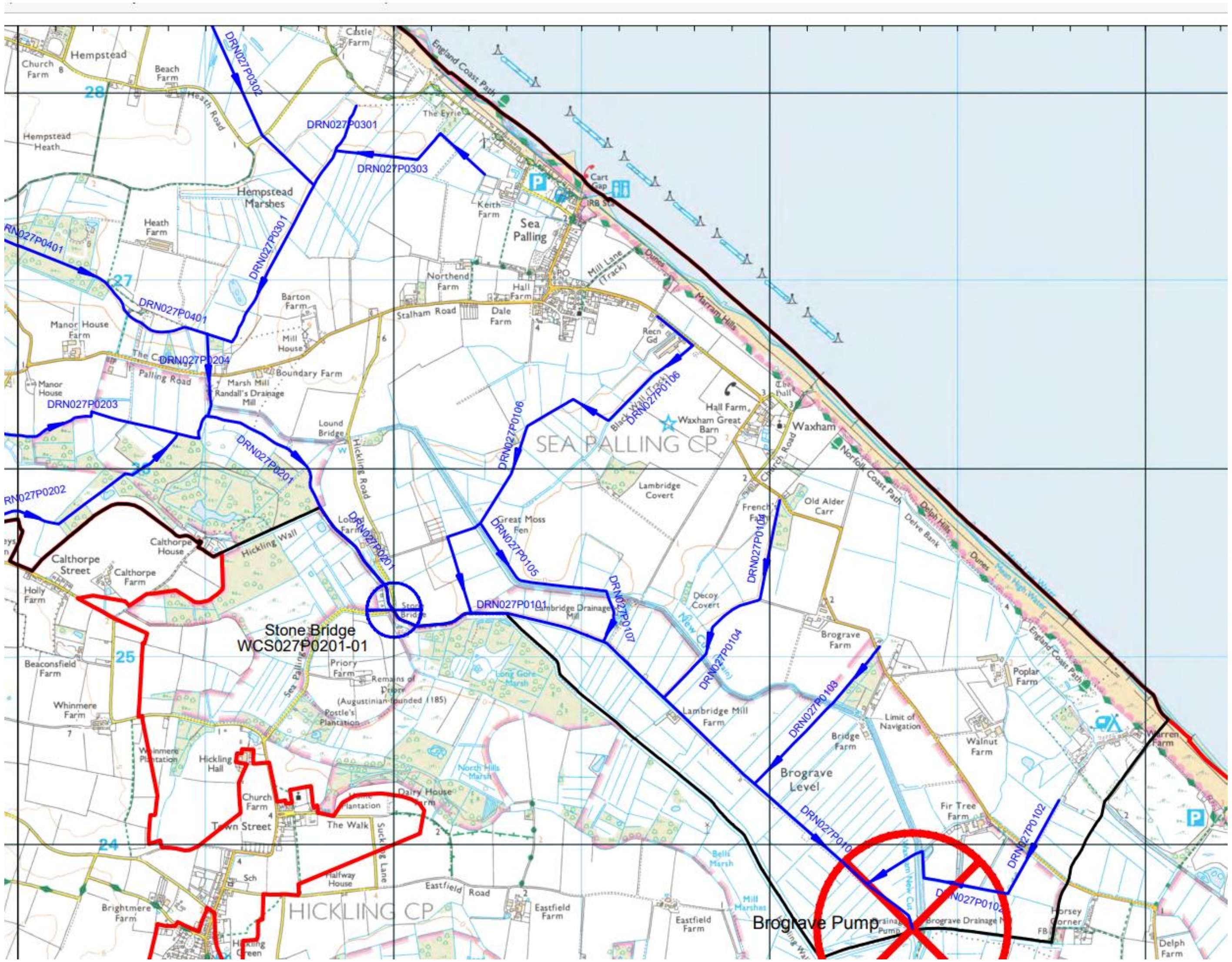
Winter



Summer



Challenges of assessing in-field watertables



Water levels:

1. IDB Main drain water levels - **unknown**
2. Non-IDB drain water levels – **unknown**
3. Presence of under-drains **– unknown**
4. Condition of under-drains **– unknown**
5. Pump on-off levels - **known**

Water level controls:

1. Levels of IDB water control structures – **known**
2. Non-IDB water control structures – **unknown**

Estimating GHG emissions from peat

- Emissions are a function of watertable depth
  - High watertable ⇨ CH_4 emissions
  - Low watertable ⇨ CO_2 emissions

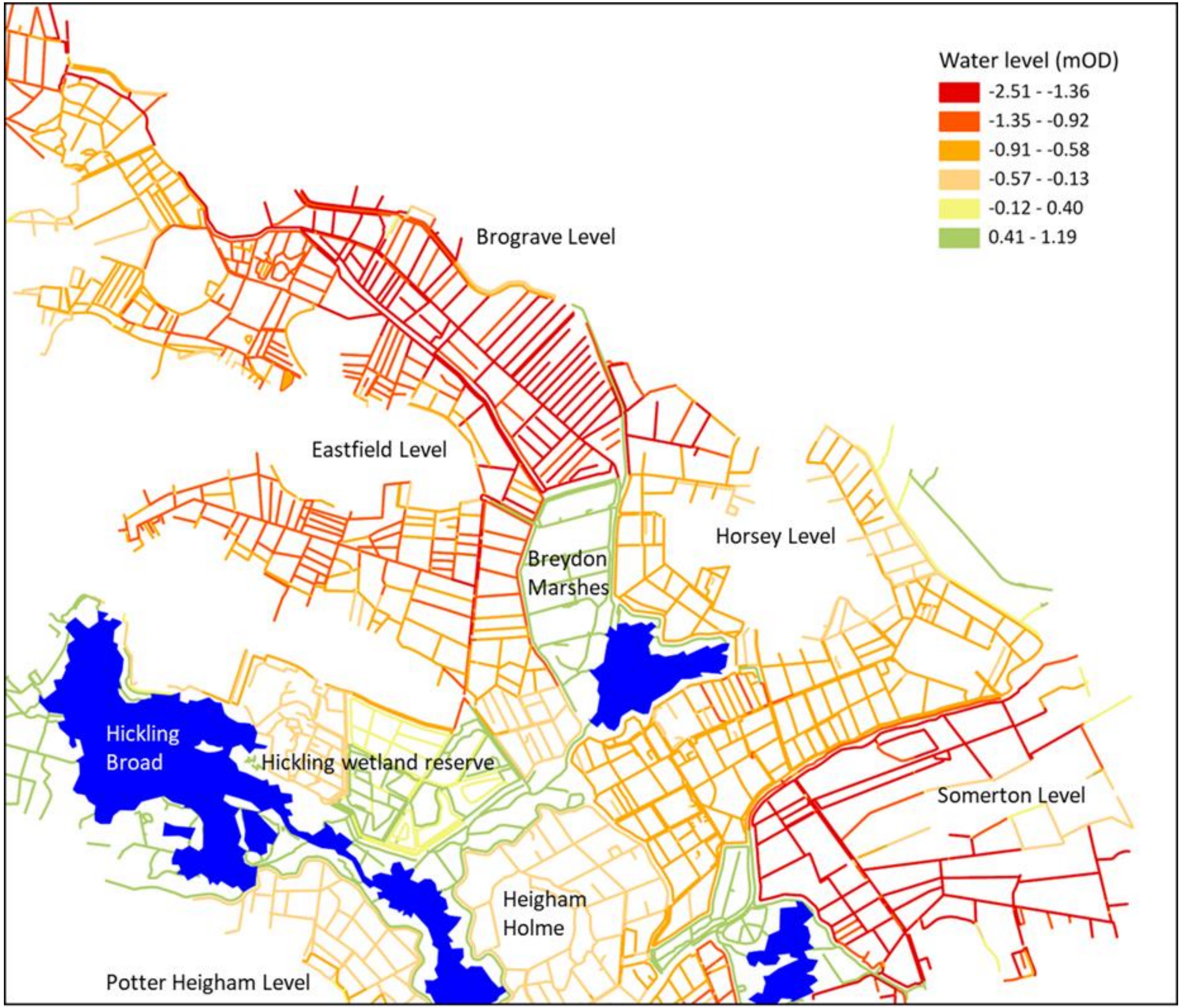
- Watertable depth depends on:
  - Weather (time of year)
  - Drainage (surface water level / freeboard)
  - Drain spacing
  - Landcover (evapo-transpiration)
  - Additional water inputs e.g. groundwater discharge / flooding

Deriving peatland GHG emissions in The Broads, UK

1. Derived drain water level height for all fields within the areas of peat soils
   - Validated against IDB on-off levels and EA gaugeboards
2. Calculated the average freeboard (difference between the elevation of the drain water level and the field) for each field;
3. Estimated drain spacing for all fields;
4. Simulated water table depth for all fields, taking account of freeboard, drain spacing and landcover
   - Validated against EA dipwell data
5. Calculated annual average effective watertable depth to take account of peat thickness;
6. Calculated CO_2 and methane fluxes using regression equations from Evans et al. (2021)

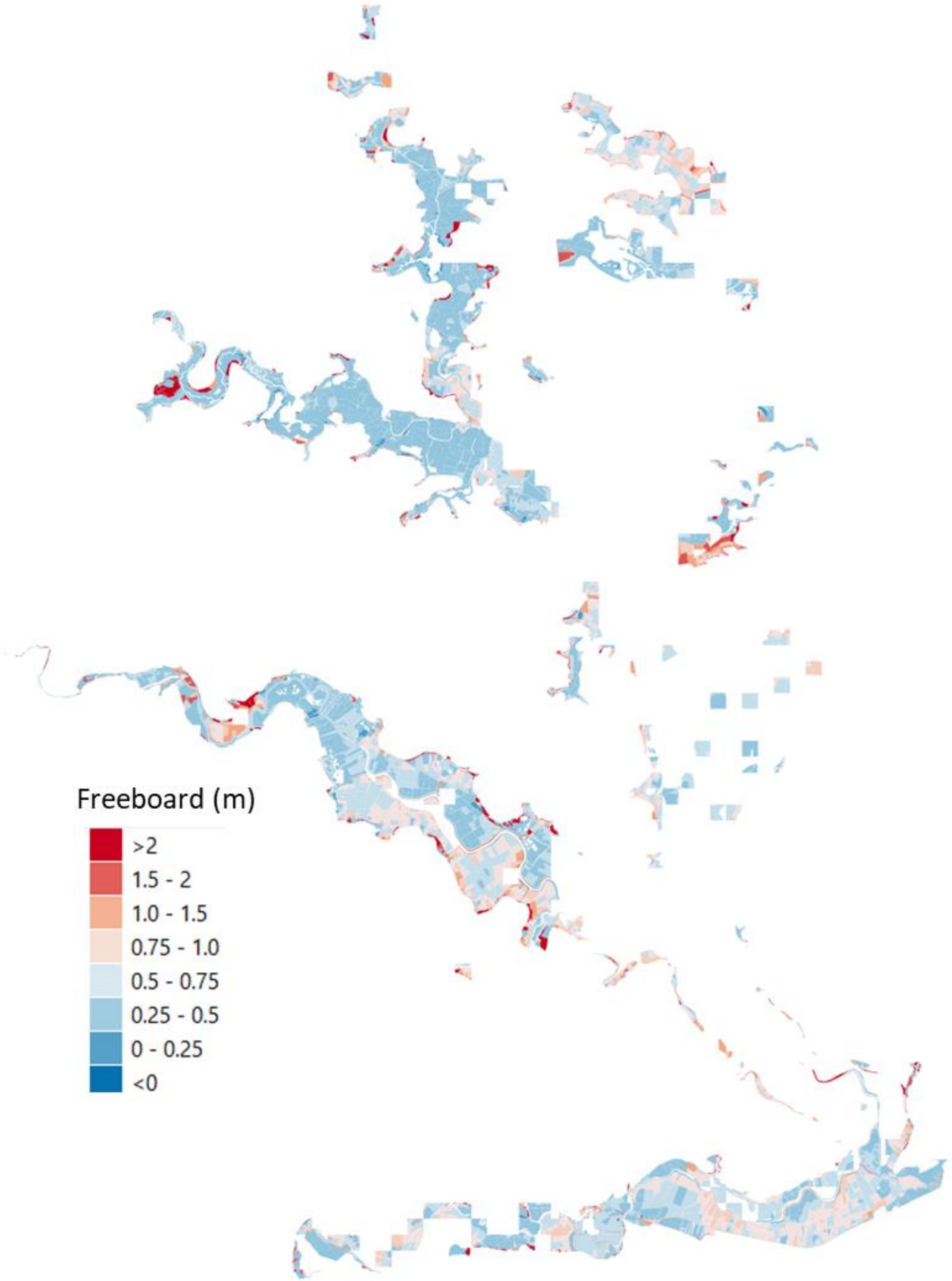
Results

1. Derived drain water level height;



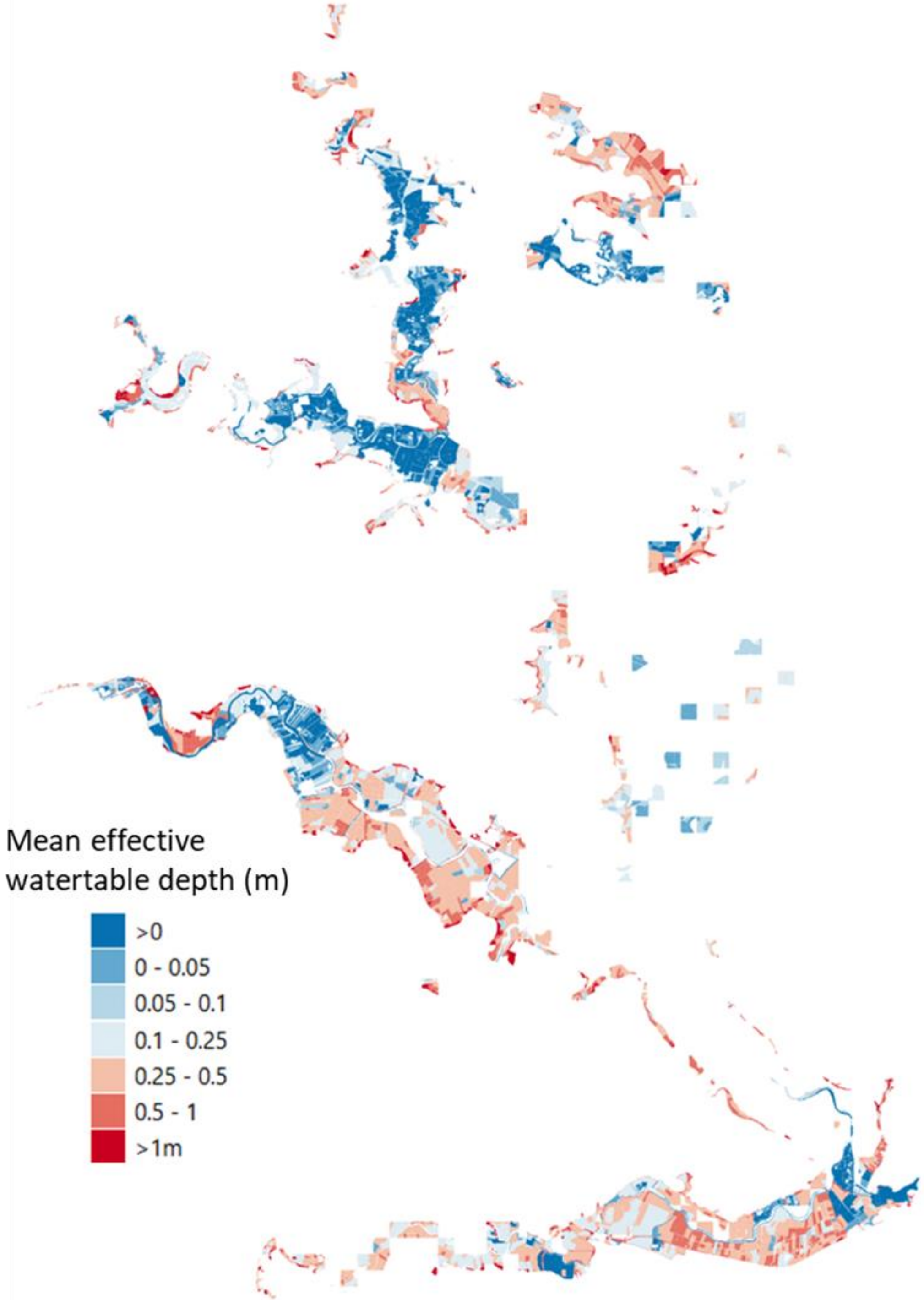
Results

2. Calculated the average freeboard for each field



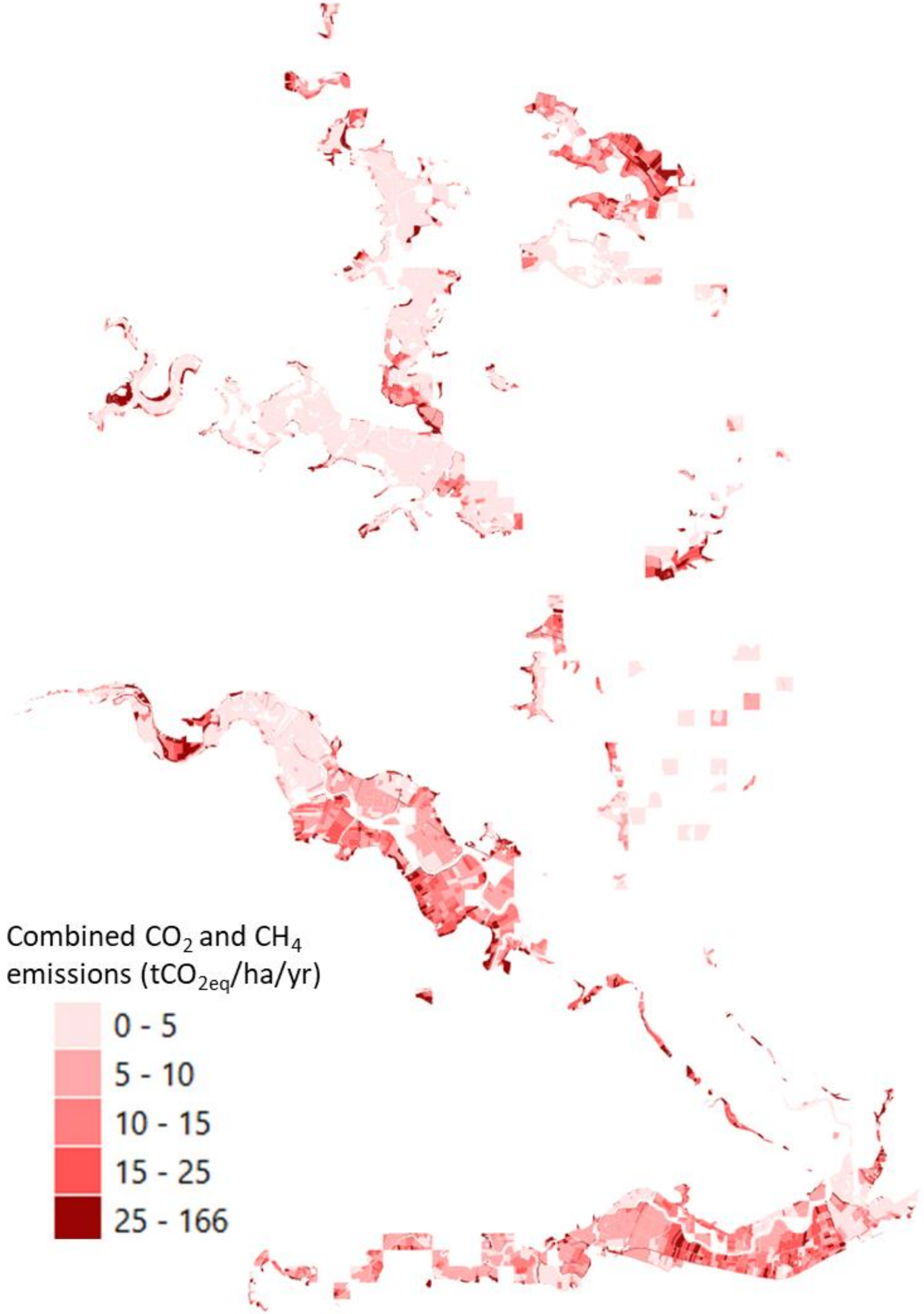
Results

3. Estimated drain spacing for all fields based on field geometry;
4. Simulated water table depth for all fields
5. Calculated annual average effective watertable depth to take account of peat thickness;



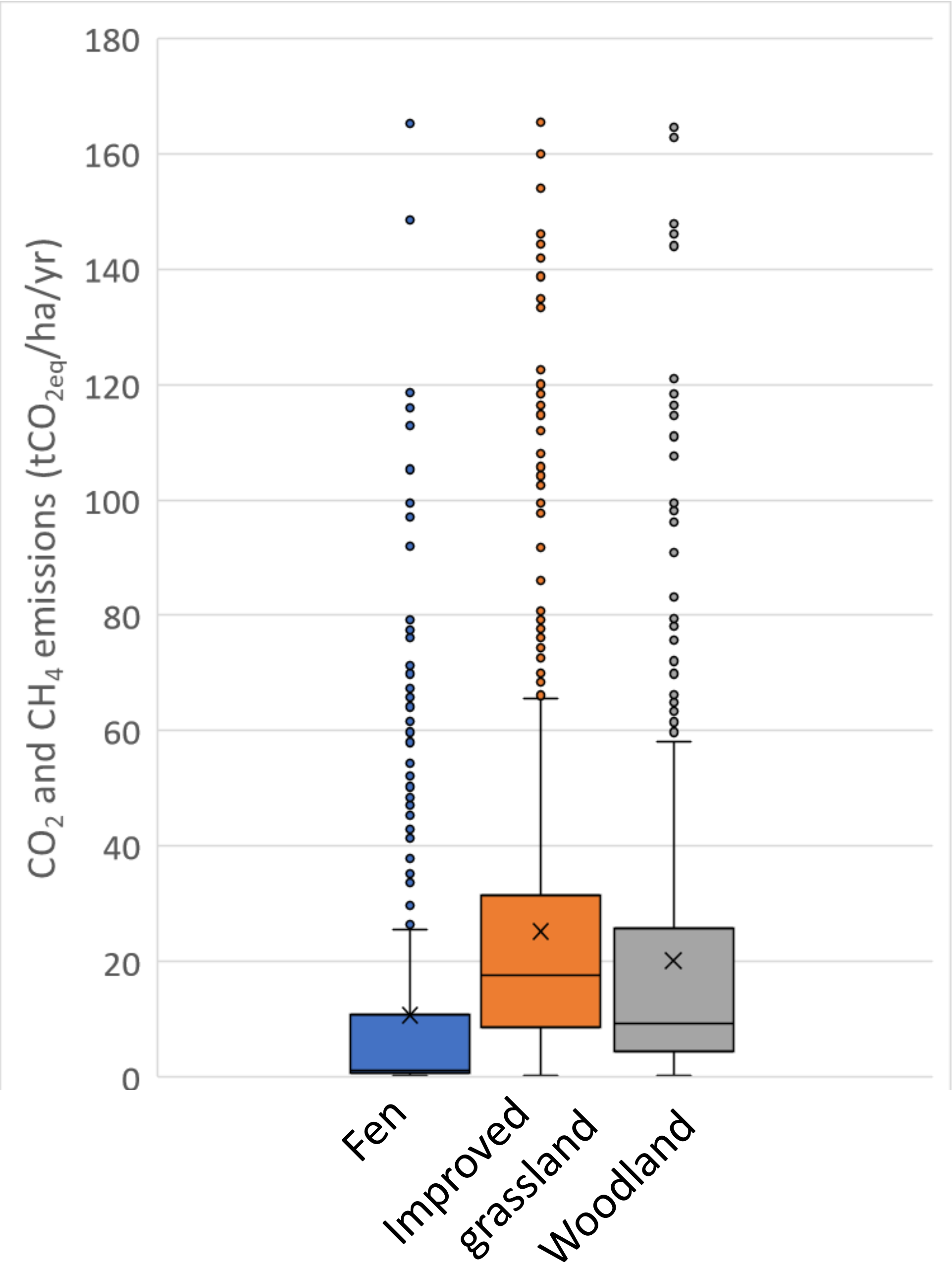
Results

6. Calculated emissions (in tCO_{2eq}/ha/yr) that takes account of the differing Global Warming Potential of CO_2 and CH_4



Lowest values generally seen in areas of Fen (highest watertables)

Emissions by habitat



Combined Emissions Factors (t CO_{2eq} ha^{-1} yr^{-1}) [Direct CO_2 + Direct CH_4]

	This study (median)	Evans et al. (2023)
Improved grassland (inc arable)	17.63	12.74 – 27.11*
Woodland	9.36	-
Fen	1.19	-1.05 - +2.43**

* Extensive grassland to cropland (peat > 40cm)

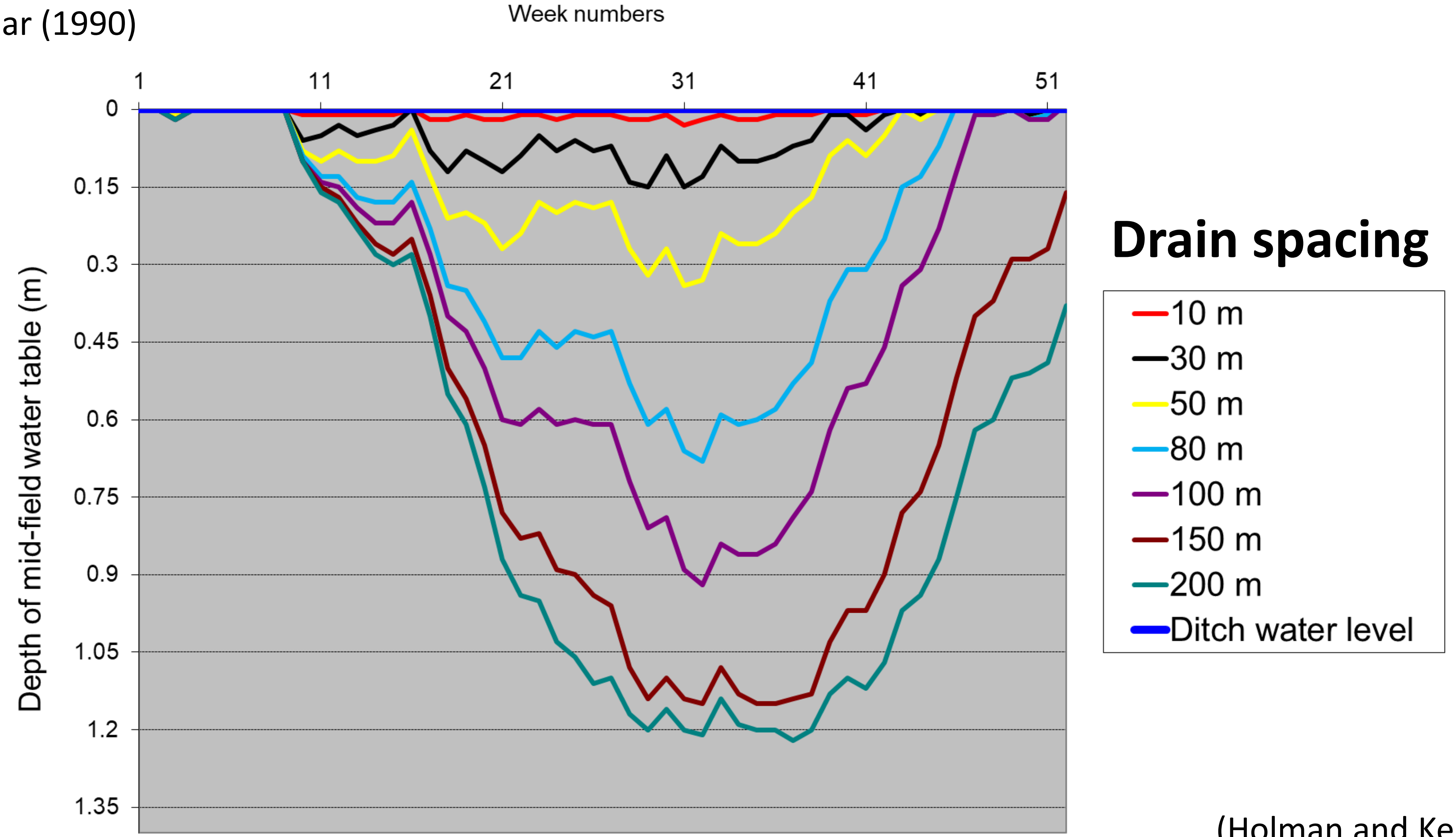
** Near-natural Fen to Rewetted Fen

Evans et al. (2023) Defra project report SP0822

Reducing emissions

High drain water levels ≠ high watertable

Dry year (1990)



(Holman and Kechavarzi, 2011)

Conclusions

- Water management of peatlands is key driver of GHG emissions

- Watertable depth is function of weather, drain water level, soil properties and distance from drain

- First spatial modelling of emissions from peats in Broads (and possibly in UK)

    - High spatial diversity in emissions, due to variability in drainage, habitats, drain spacing etc

    - Highest emissions associated with improved grassland / cropland and lowest with Fen

    - Derived Emissions Factors broadly similar to published national values

- Reducing emissions requires watertable management - high drain water levels don’t necessarily mean a high watertable

Acknowledgements

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- Neil Klotz (Environment Agency) for shallow dipwell and stage board data

E: i.holman@cranfield.ac.uk

T: +44 (0) 1234 75 8277

W: www.cranfield.ac.uk/people/professor-ian-holman-787215

@cranfieldduni
@cranfieldduni
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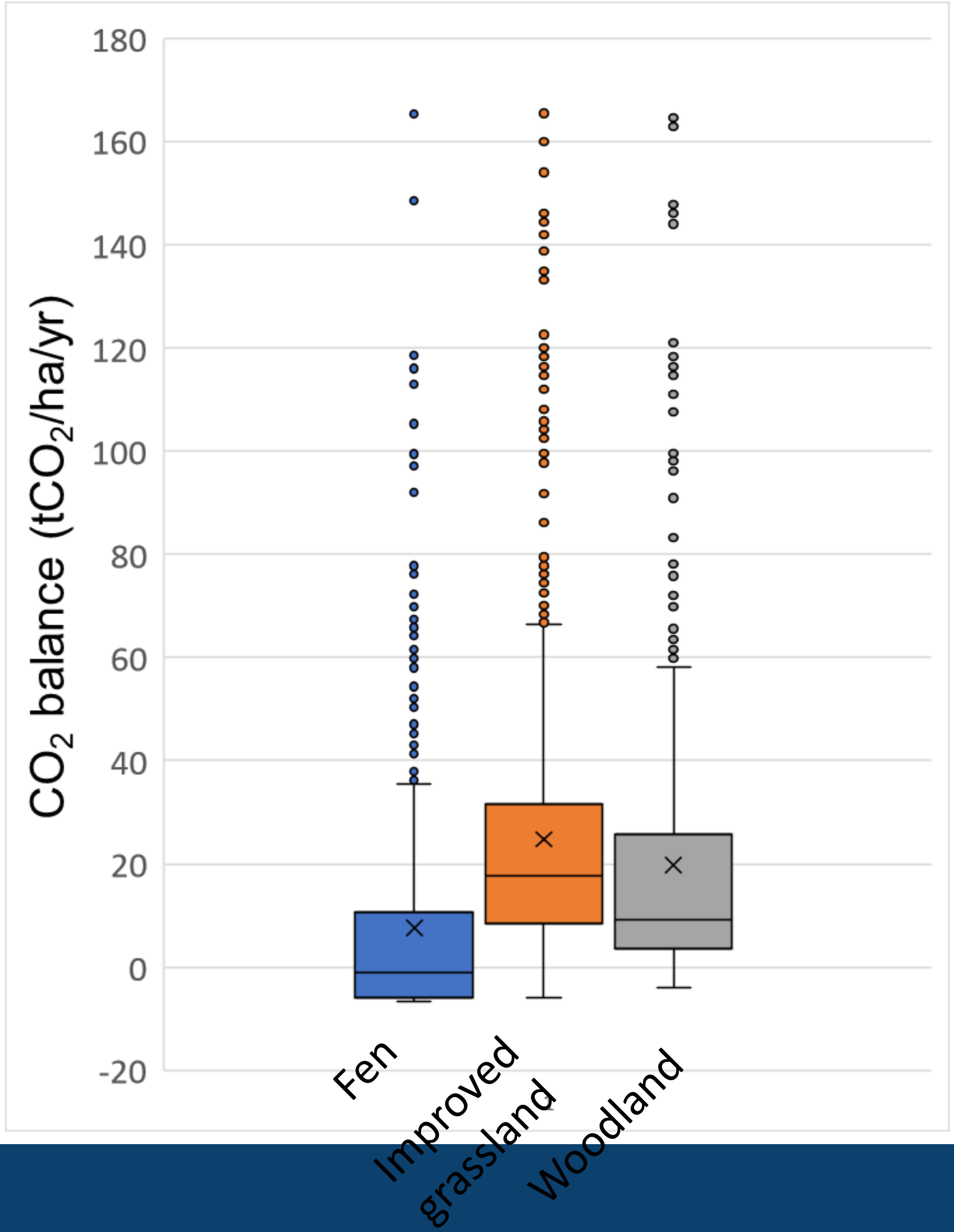
Emissions by habitat



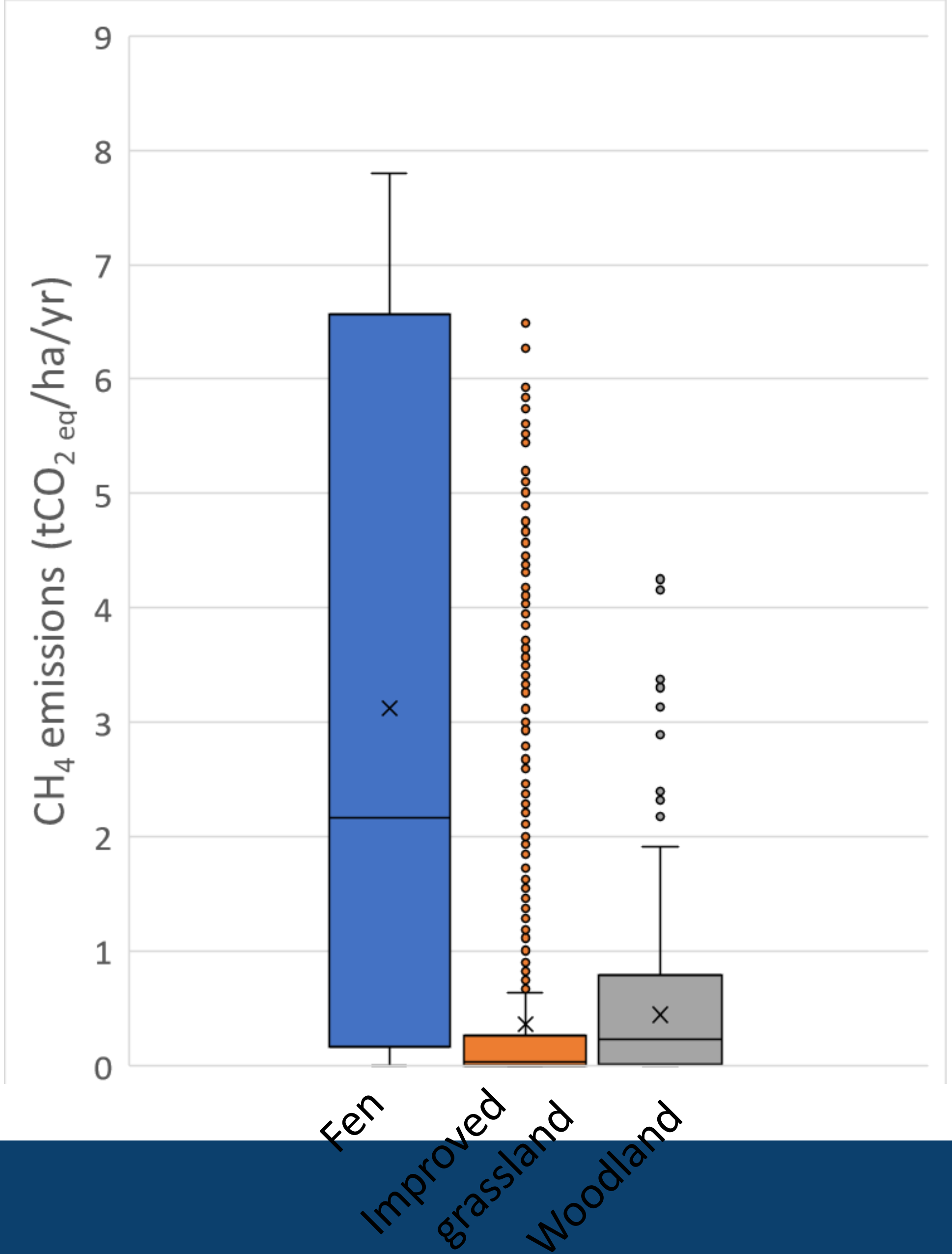
Emissions Factors (t CO_{2eq} ha^{-1} yr^{-1}) [Direct CO_2]

	This study (median)	Evans et al. (2023)
Improved grassland (inc arable)	17.59	11.78 – 27.06*
Woodland	9.13	-
Fen	-0.97	-5.06 to -0.69**

* Extensive grassland to cropland (peat > 40cm)

** Near-natural Fen to Rewetted Fen

Emissions by habitat



Emissions Factors (t CO_{2eq} ha^{-1} yr^{-1}) [Direct CH_4]

	This study (median)	**Evans et al. (2023)**
Improved grassland (inc arable)	0.03	0.05 – 0.96*
Woodland	0.23	-
Fen	2.17	3.12 - 4.01**

* Extensive grassland to cropland (peat > 40cm)

** Near-natural Fen to Rewetted Fen