



Innovative Water Table Modelling Supporting Water and Carbon Management

Ian Holman, Saghar Andaryani, Andrea
Momblanch

January 2025

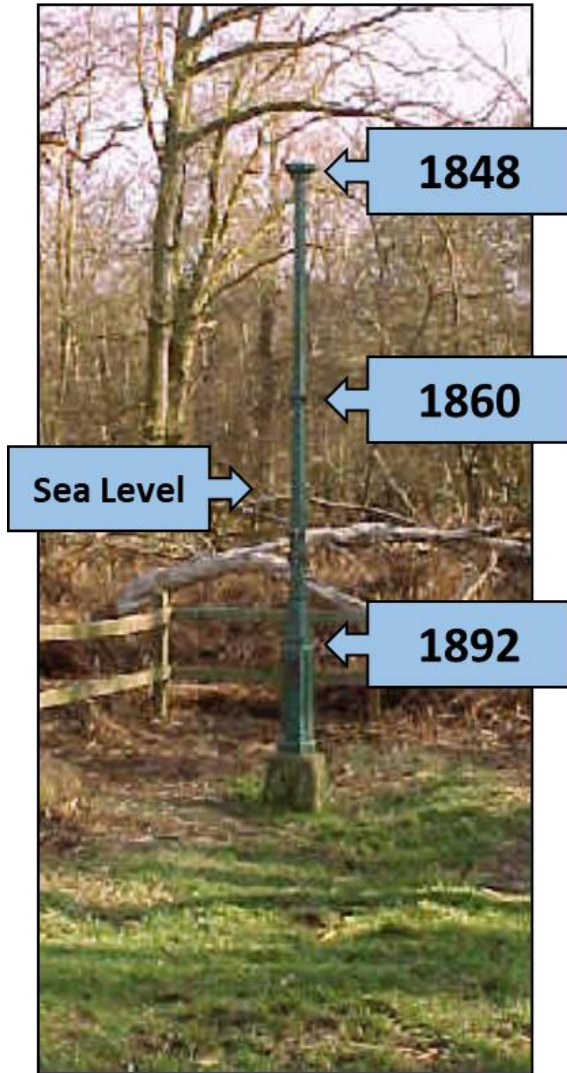
www.cranfield.ac.uk



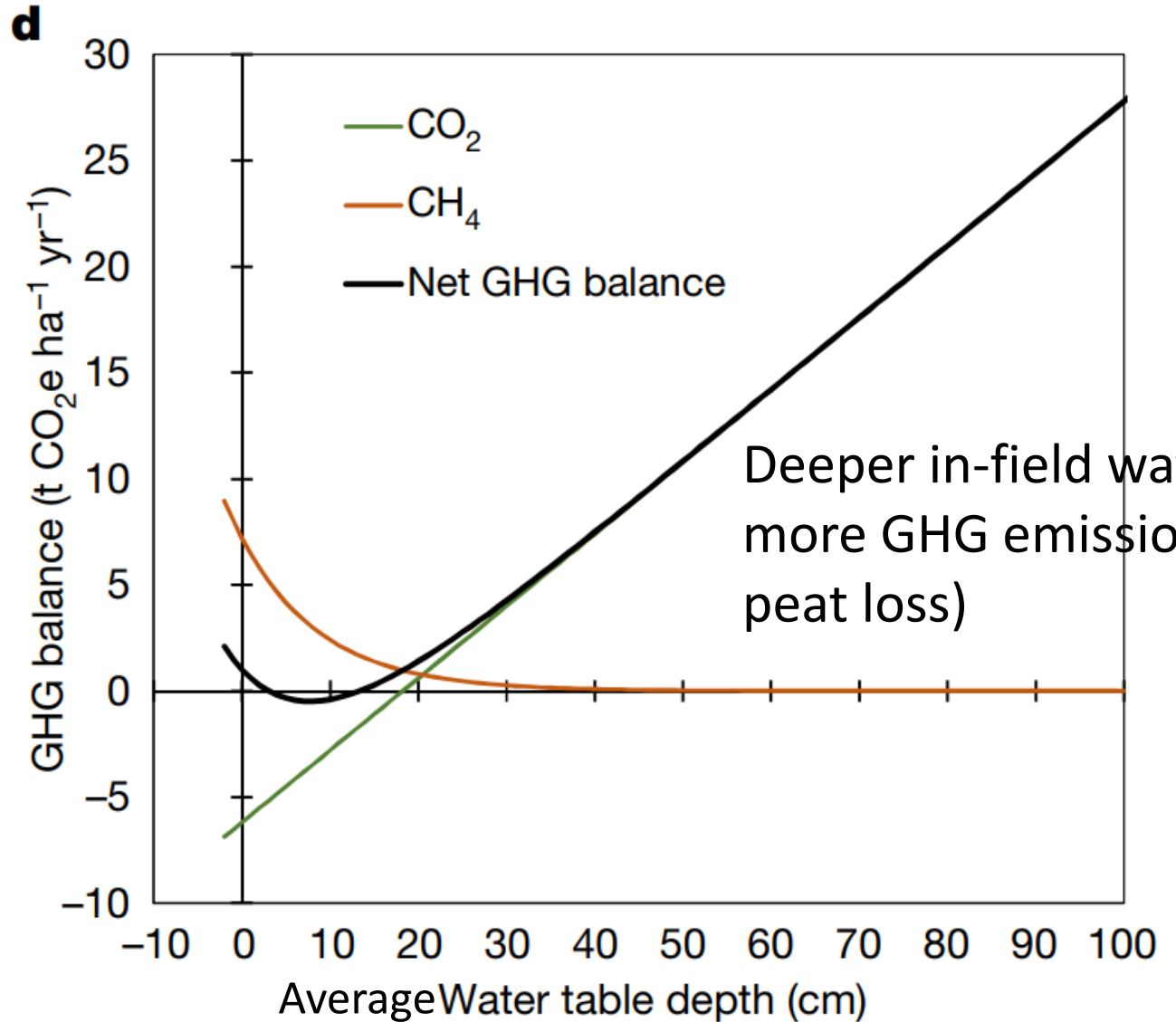
Overview

- Basics of land drainage for watertable control (freeboard and drain spacing)
- The challenge(s) of assessing in-field watertables
- Our approach and tool.....
- Final remarks

Importance of watertable management



GHG emissions



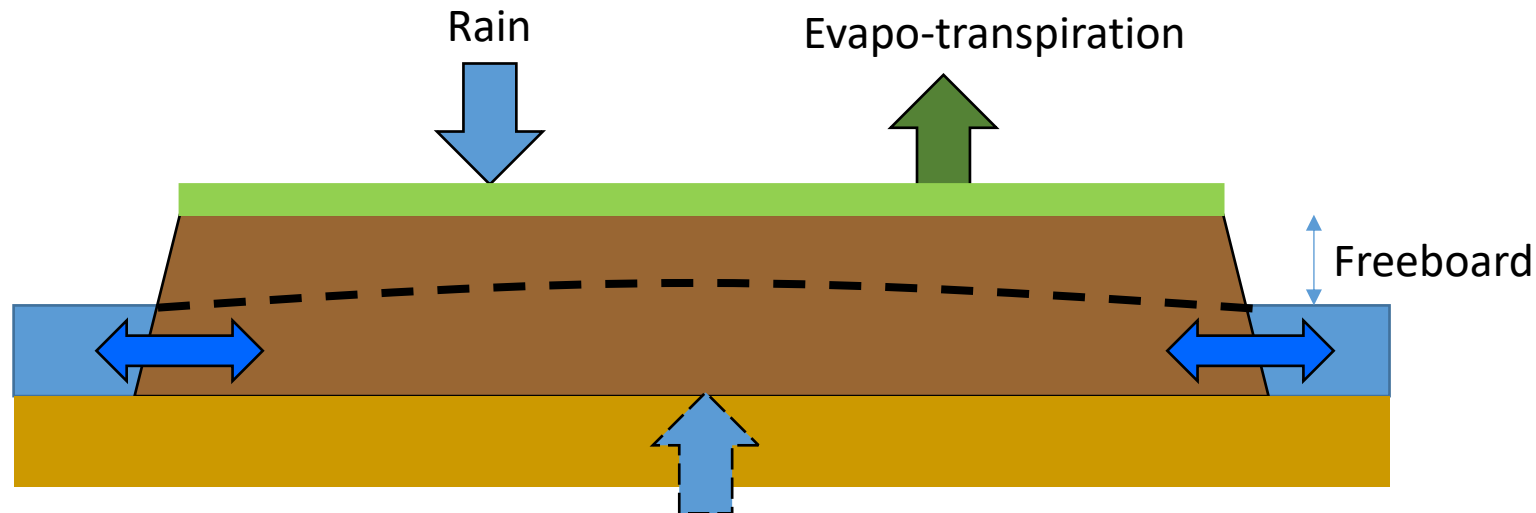


Basics of drainage

Watertable depth in LAP is a function of drainage regime, water inflows and water outflows

Watertable shape is a parabola that changes with :

- distance from drain
- Peat properties (K_{sat})

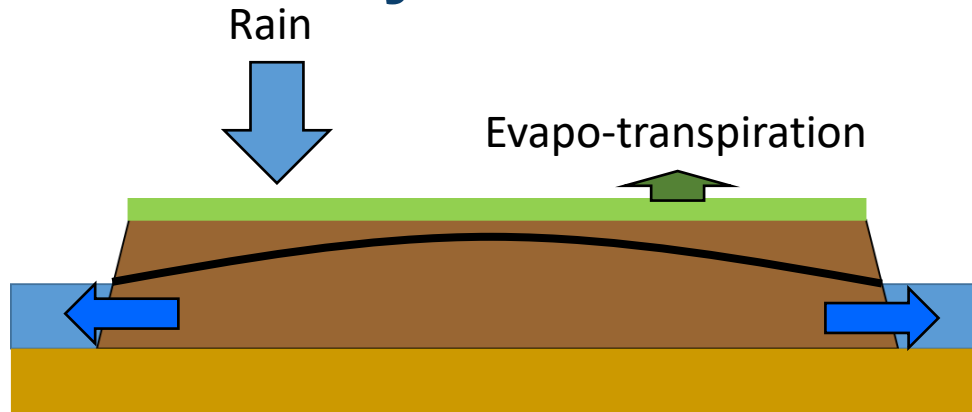


Key WT controls

- Drain spacing
- Freeboard (drain water level)
- Peat properties (K_{sat} and S_y)
- Weather
- Groundwater

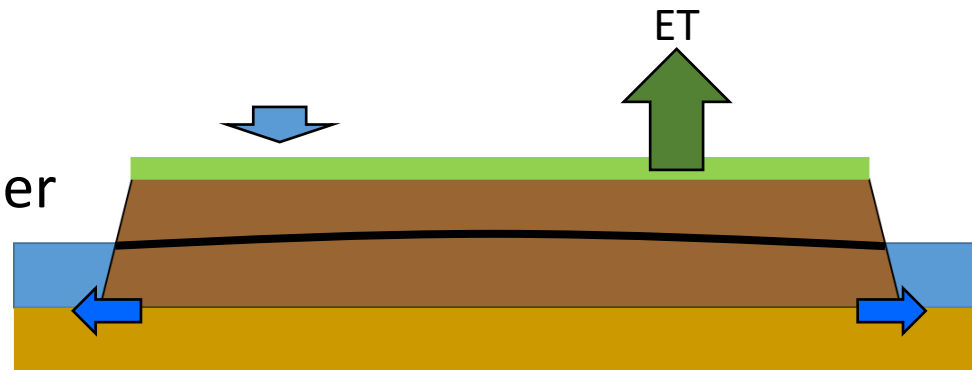
Seasonality

Winter



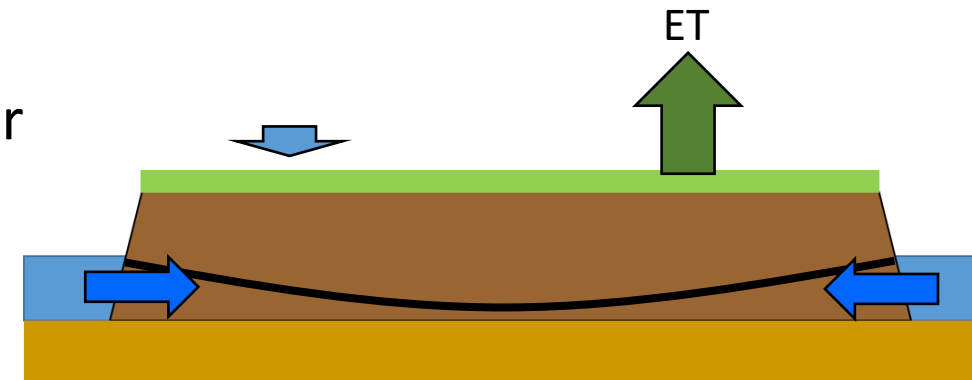
- Watertable level above drain water level
- Watertable highest **midway between** drains

Early summer



- Watertable level falls
- Watertable highest **midway between** drains

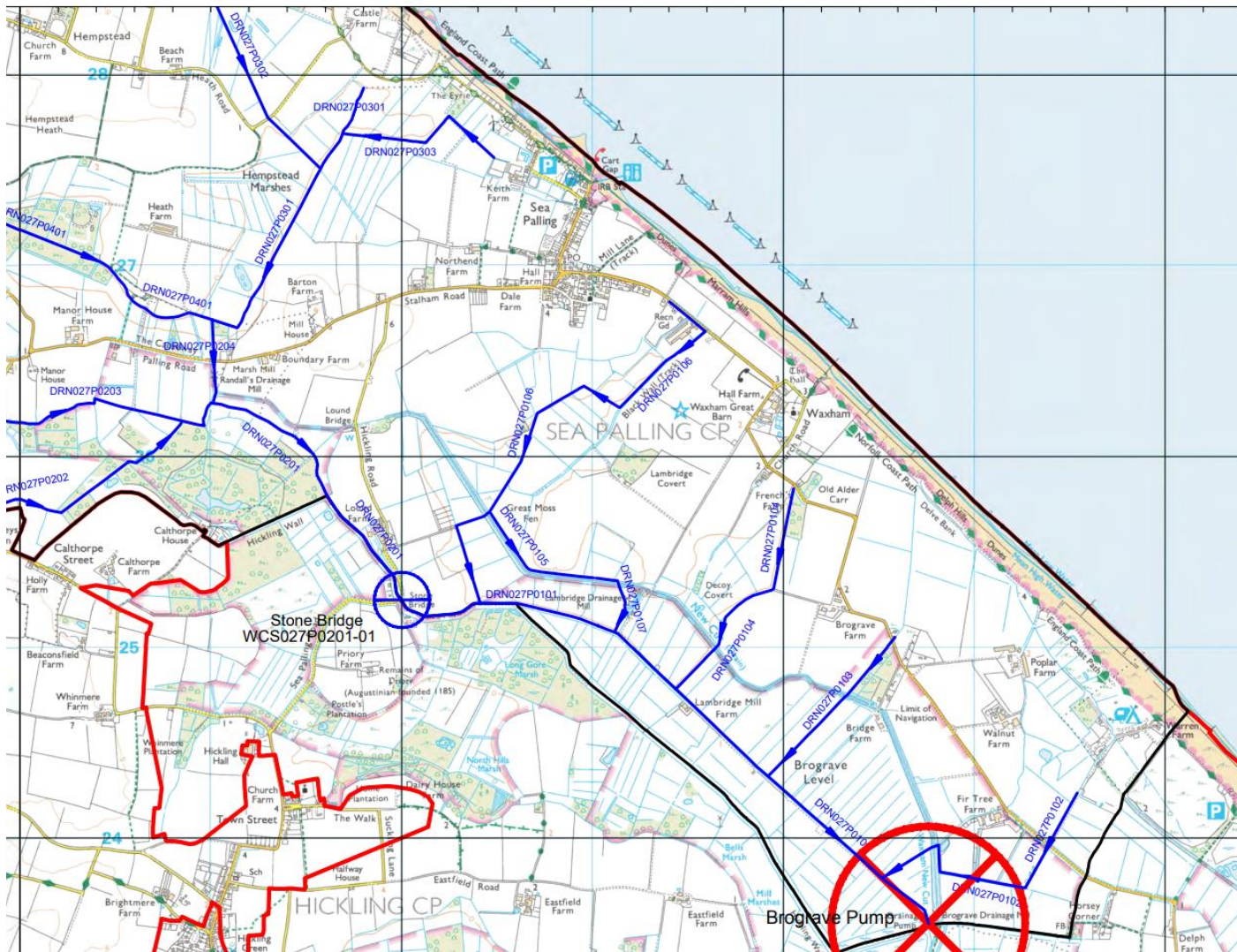
Late summer
/ dry years



- Watertable level continues to fall due to ET
 - $AET >$ rate of 'sub-irrigation'
- Watertable highest **near** drains



Challenges of assessing in-field watertables



- Presence of ditches – **known**
- IDB Main drain water levels - **unknown**
- Non-IDB drain water levels – **unknown**
- Presence of under-drains – **unknown**
- Condition of under-drains – **unknown**
- Pump on-off levels – **known**
- Watertable depth – **(largely) unknown**



Our approach

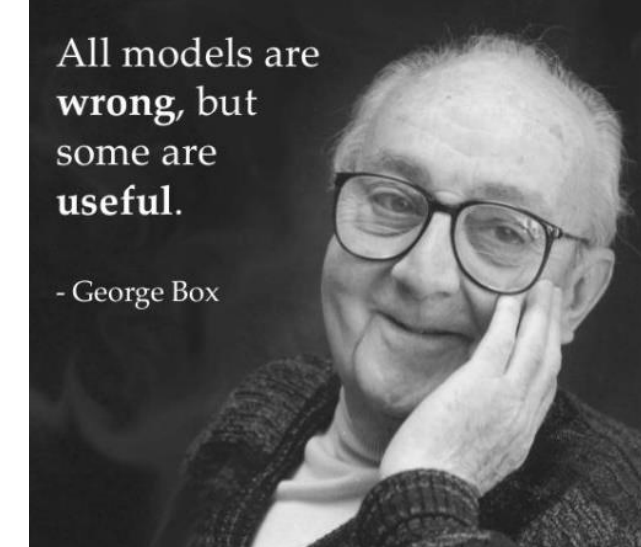
Ordnance Survey mapping



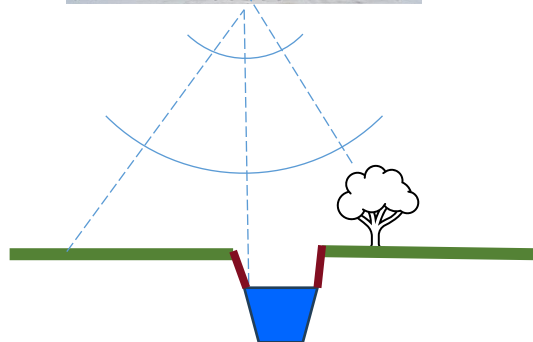
Drain spacing

All models are **wrong**, but some are **useful**.

- George Box



Lidar (radar)



Evaluation against:

Source: ADA



Source: Defra

- Drain water levels
- Field (ground) elevation
 - Freeboard

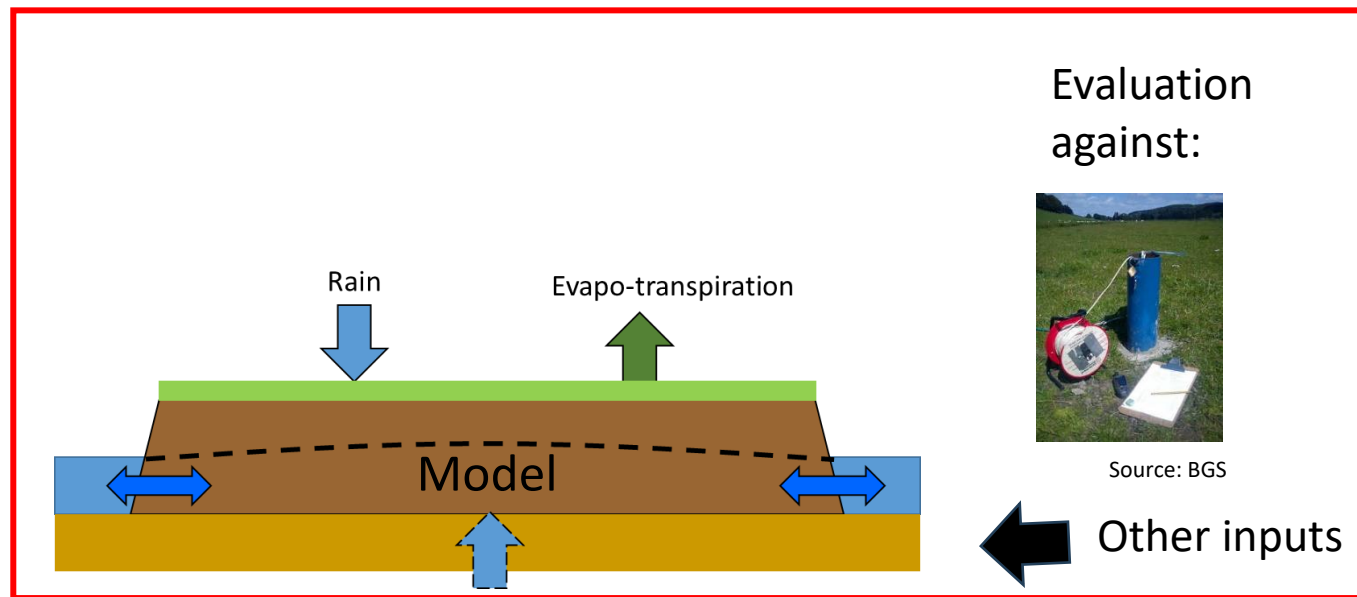


Evaluation against:



Source: BGS

Other inputs



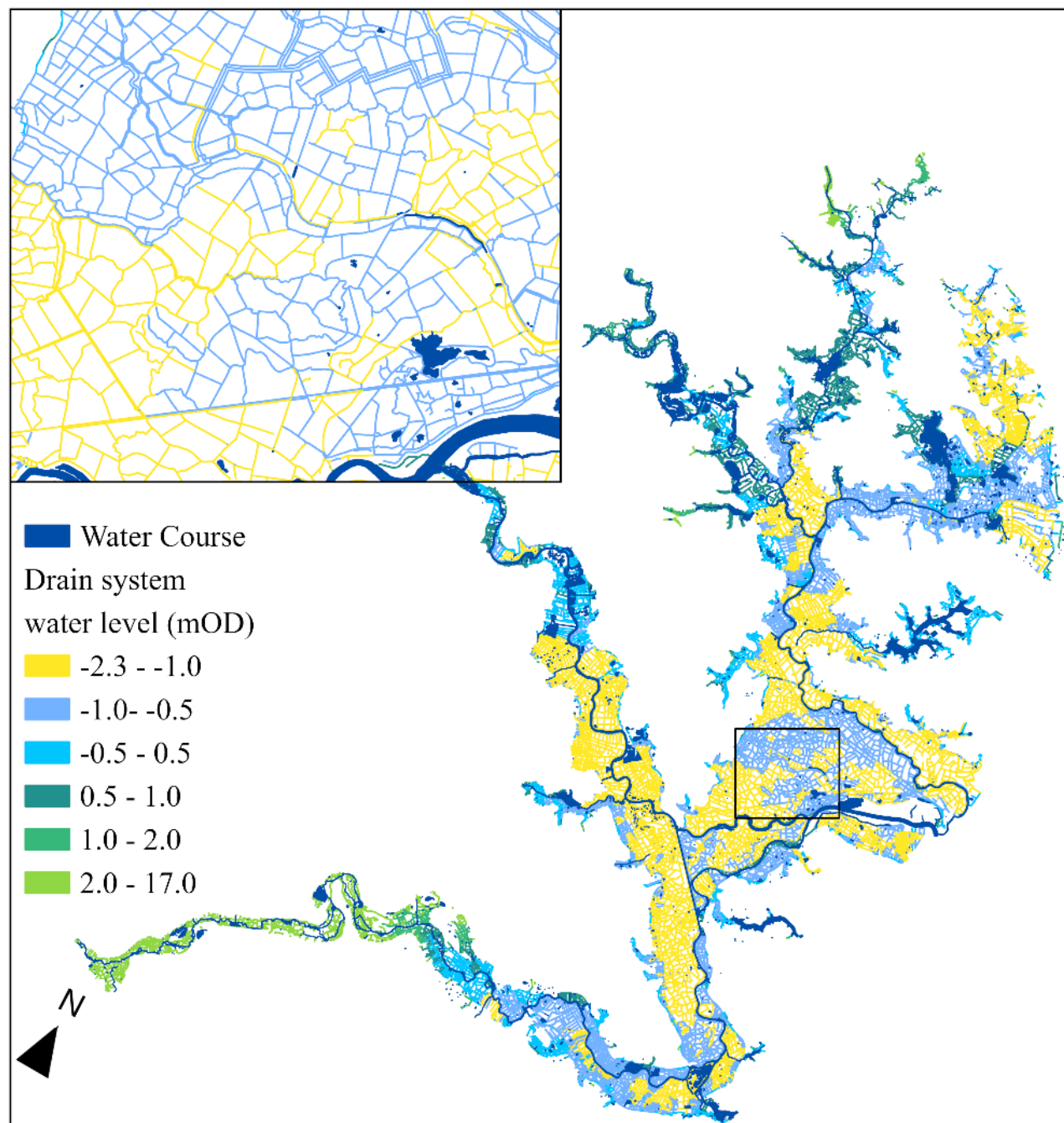
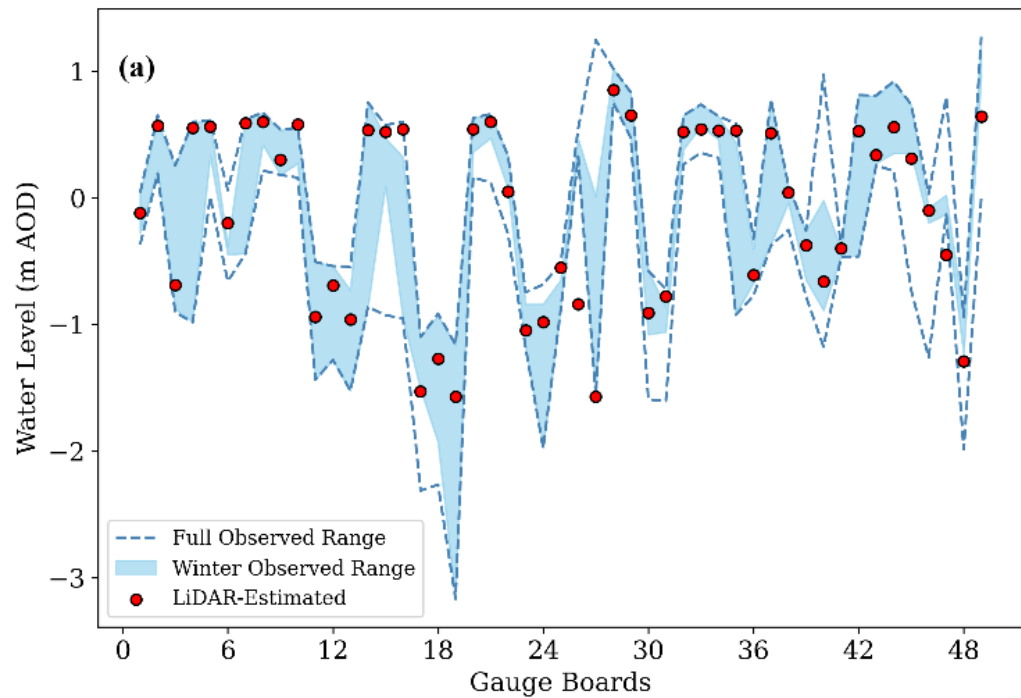
GHG emissions

Drain water level scenarios





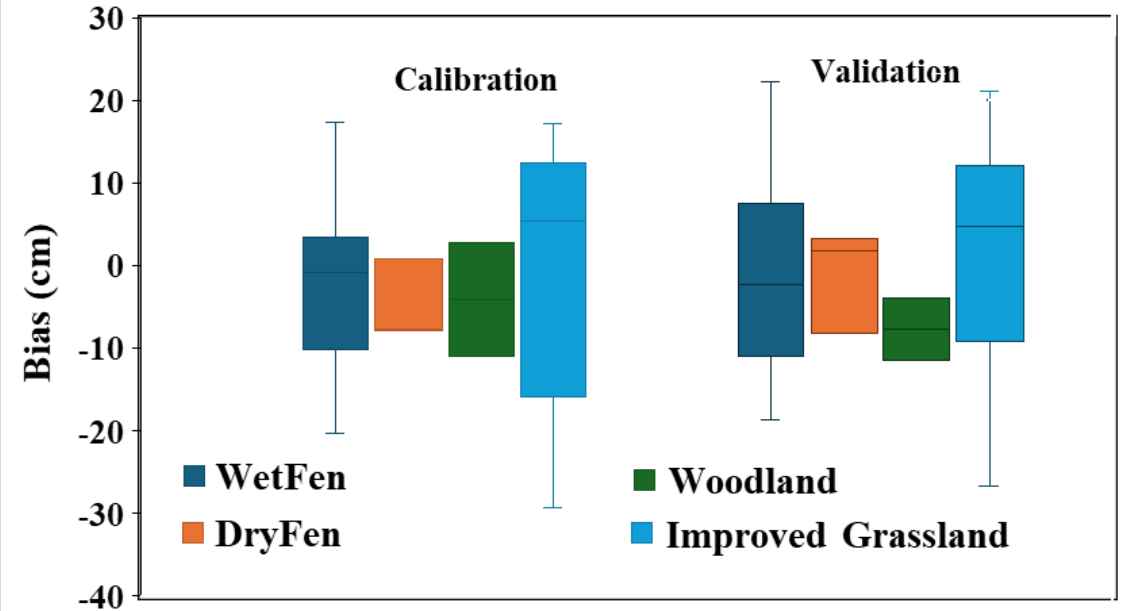
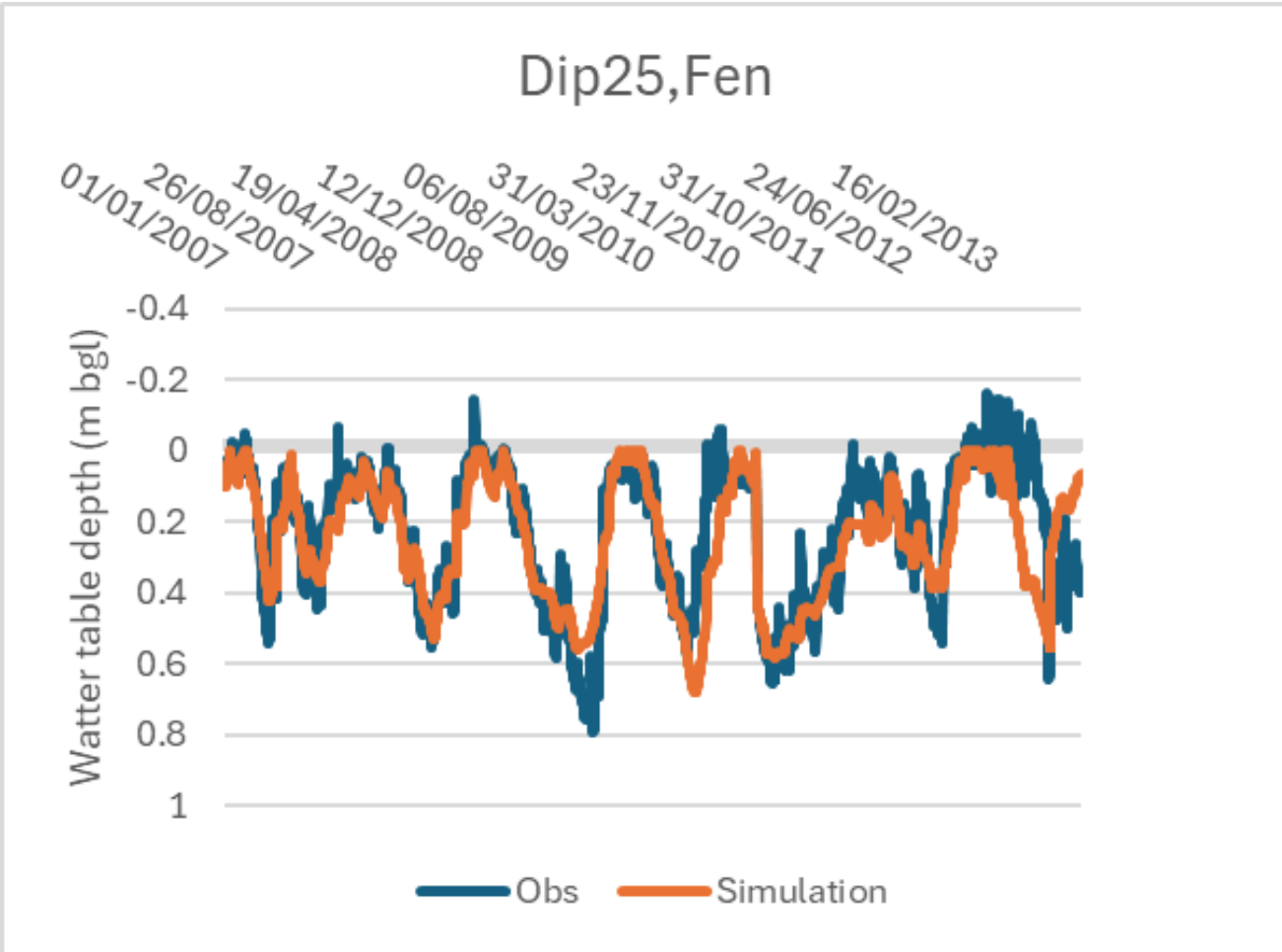
Drain water levels (mOD)





Water table (dipwells)

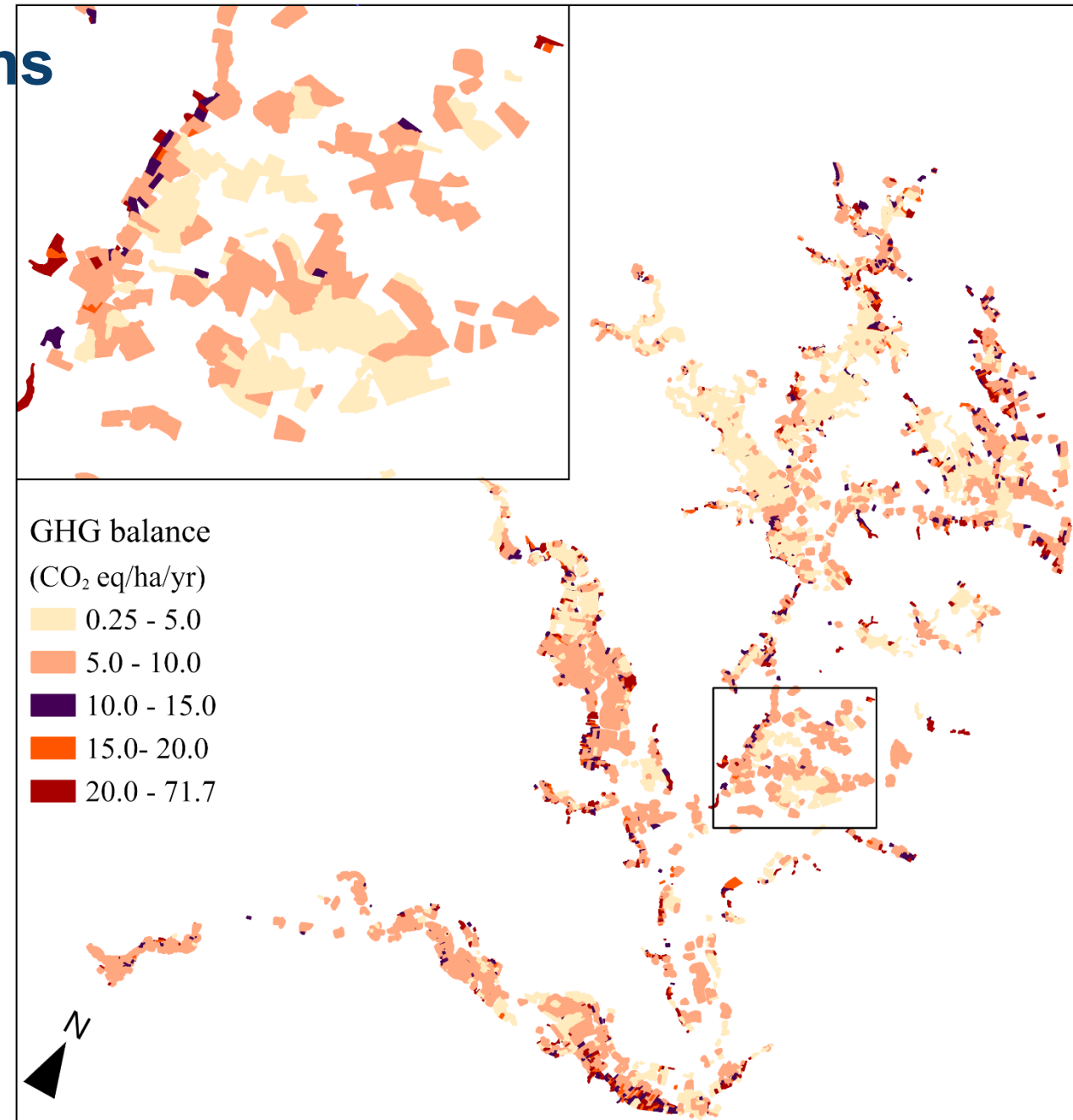
Example (a good one!)





Greenhouse gas emissions

- Greenhouse gas emissions differ between fields due to differences in water table depth and peat thickness



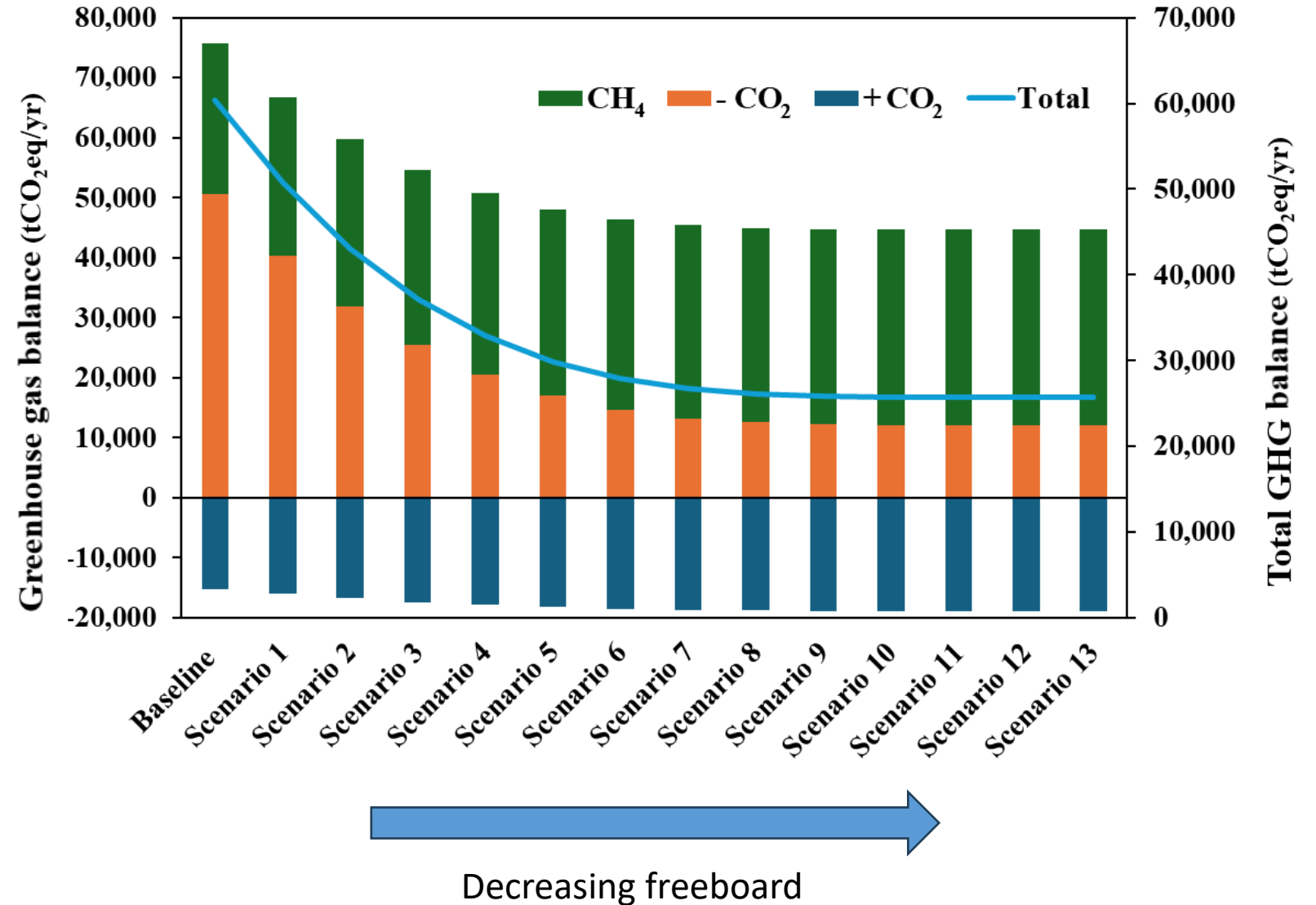


Broads National Park greenhouse gas emissions

As drain water levels are raised, emissions progressively reduce

Emissions made up of:

- CO₂ uptake in functioning high watertable peatlands
- Methane (CH₄) emissions in high watertable peatlands
- CO₂ emissions in fields that fail to achieve high average watertable





Watertable tool

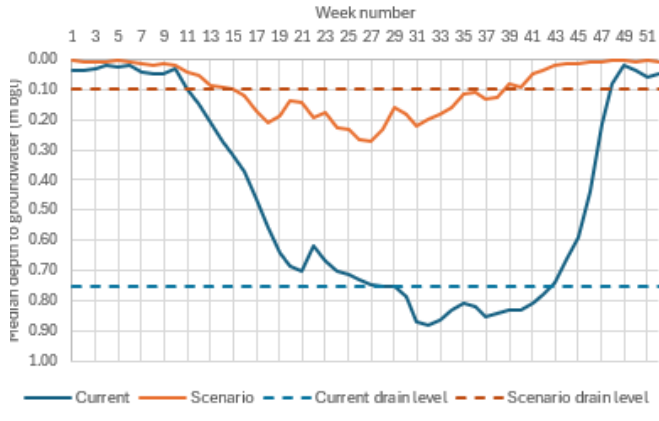
- Regional modelling is a static representation of spatial variability in watertable depth
- It doesn't support land owners (and others) in developing options and planning for raising watertables
- Developed an Excel-based tool for the Broads to quickly show how changing
 - Drain spacing
 - Drain water level
 - Surface irrigation
 - Vegetation
- Affects:
 - Watertable depth (within a year, and between years)
 - Water needs (within a year, and between years)
- Within different catchments in the Broads

The screenshot displays the user interface of the 'Watertable tool'. At the top, it features logos for Cranfield University, Broads Authority, Water Management Alliance, and Environment Agency. Below the logos, a text box states: 'This tool has been developed as part of the "Broadland PeatCam Spatial Data" Lowland Agricultural Peat Small Infrastructure Project (LAPSIP) funded by the Environment Agency'. It further explains: 'It aims to provide an indication of the effects of selected management interventions on the mid-field watertable depth, an estimate of the additional water requirements to maintain higher watertable depths and the potential increased runoff and drainage associated with higher watertables'. Two diagrams illustrate the tool's function: 'Winter' shows rain falling on a field with a high watertable, leading to evapo-transpiration and drainage; 'Summer' shows rain falling on a field with a lower watertable, leading to evapo-transpiration, groundwater inflow, and sub-irrigation. Below the diagrams, a section titled 'You can select:' lists options: 'Catchment (Ant, Thurne, Waveney and Yare)', 'Current drain spacing, drain water level and landuse', 'A scenario of changed drain spacing, drain water level and/or landuse', and 'Management option of applying additional surface water to the field'. A text input field is visible at the bottom of the interface.

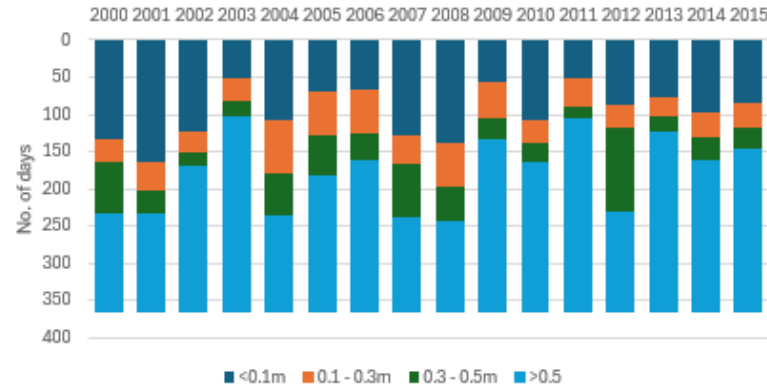


Watertable tool (example outputs)

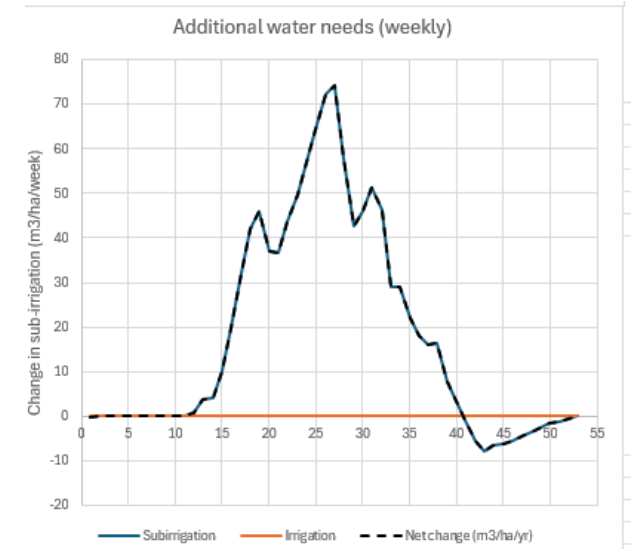
Intra-annual variability in WT depth
Depth to groundwater (mid-drain)



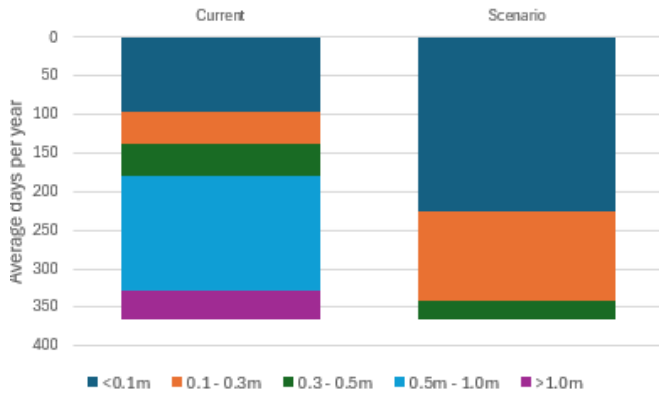
Inter-annual variability in WT depth
Current watertable depths



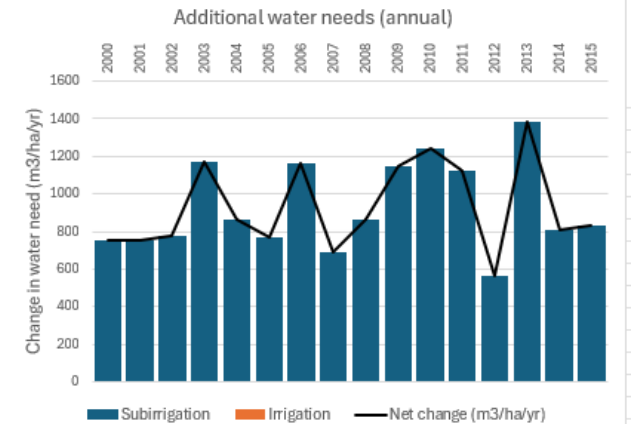
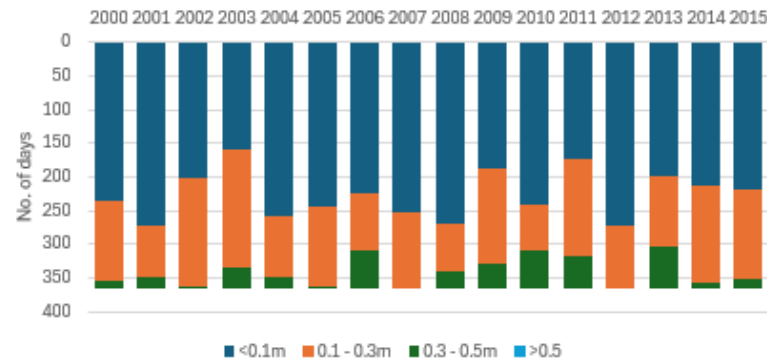
Intra- and inter-annual variability in additional water needs



Average days per WT depth band



Scenario watertable depth





Concluding comments

- We have developed an innovative approach for estimating current and future water table depth and GG emissions
- Raising and maintaining high watertables isn't straightforward.
 - Higher drain water levels lead to higher watertables and reduced emissions, but do not guarantee sufficiently high water tables.
 - Maintaining higher water table requires increased water
- We have developed a prototype tool to support and empower landowners in feasibility discussions



Acknowledgements

Original work commissioned by the Broads Authority for the Broads Peat Partnership. It was funded by the Nature for Climate Peatland Grant – Discovery Grant, and Cranfield University

Updated Broads watertable modelling funded as part of the Environment Agency Lowland Agricultural Peat Water Discovery Pilot projects and Defra-funded Lowland Peat 3 model

Excel tool funded as part of the Environment Agency Lowland Agricultural Peat Small Infrastructure Project

Thanks to:

- Ashish Dutta and Ian Truckell (Cranfield University) for method development
- Thomas Jones (Water Management Alliance) for pump levels
- 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

 @cranfielduni

 @cranfielduni

 /cranfielduni