Roadmap to Inclusion of Saltmarsh in the UK GHGI

Annette Burden and Hannah Clilverd

UKCEH Our planet. Decoded.

What is a Greenhouse Gas Inventory (GHGI)?

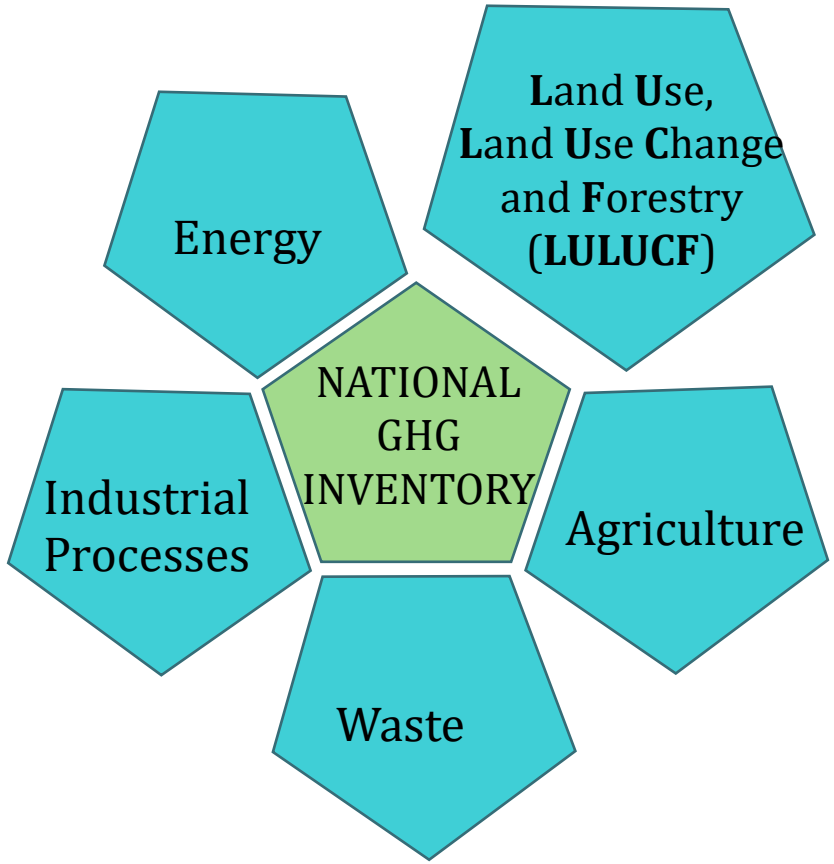
- Detailed year-on-year assessment of national GHG emissions.
- Needed for monitoring progress towards global (**UNFCCC 1994, Paris Agreement 2015**) and national (**Climate Change Act 2008, Net Zero amendment 2019**) commitments on reducing GHGs.
- Consists of complex database and models of annually-updated values for each year (1990 onwards).
- Follows international protocols (**IPCC 2006, 2013**) & audit to allow international comparison.

National Atmospheric Emissions Inventory

Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

https://naei.energysecurity.gov.uk/

Llywodraeth Cymru
Welsh Government



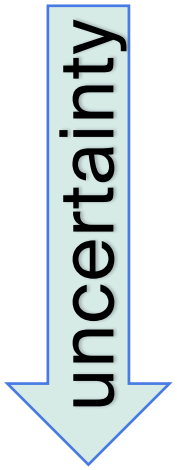
Department for Energy Security & Net Zero

The Scottish Government

Department for Environment Food & Rural Affairs

Principles of inventory compilations

Robust and well-tested framework for monitoring and reporting of GHGs



Tier 1 IPCC default emission factors and other parameters

Tier 2 Country-specific emission factors and other parameters

Tier 3 Higher order methods and models

Emission factor:

A representative value that relates a pollutant quantity released to/removed from the atmosphere relative to a specific unit of activity.

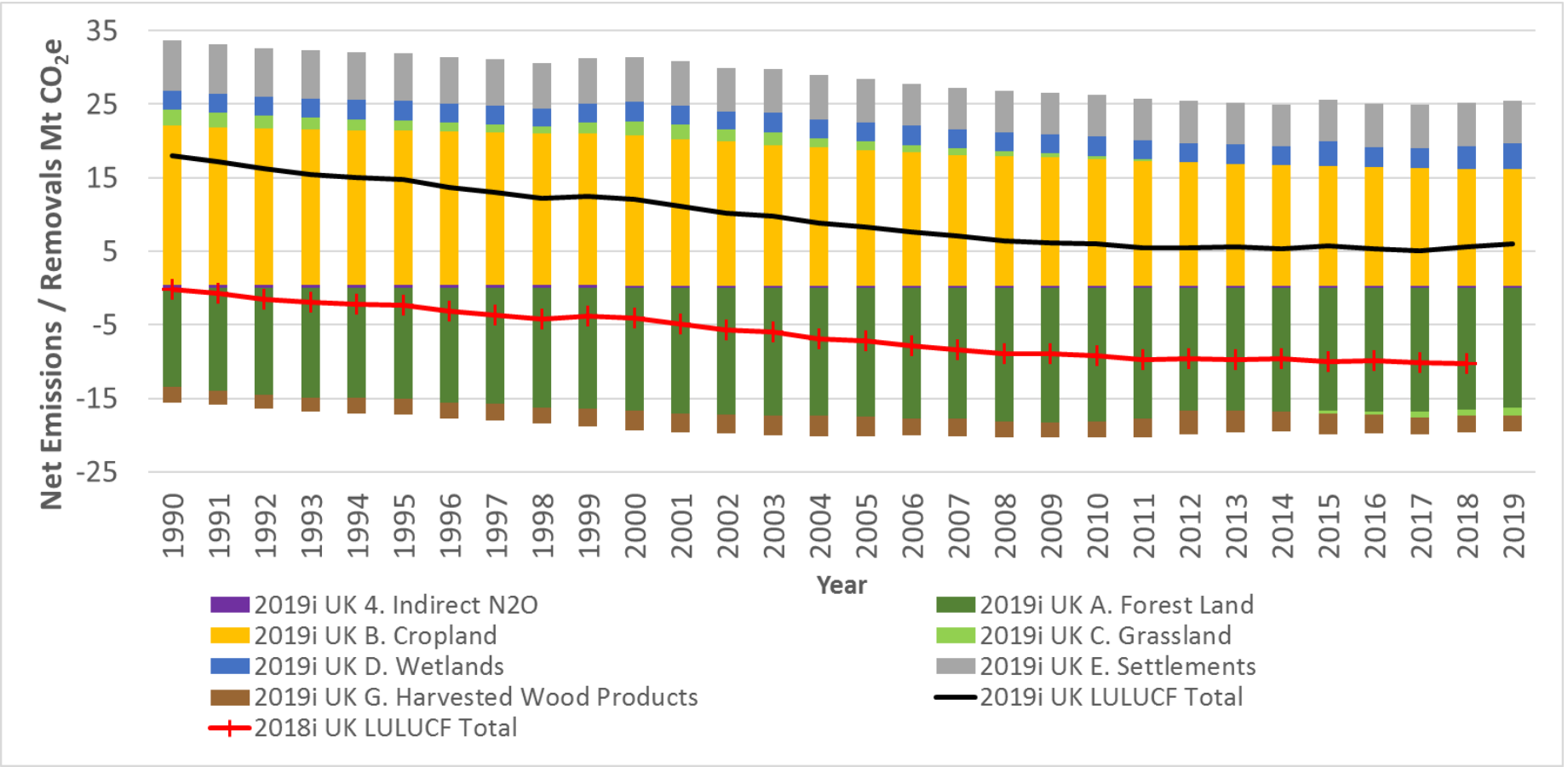
Transparent • Consistent • Comparable • Complete • Accurate

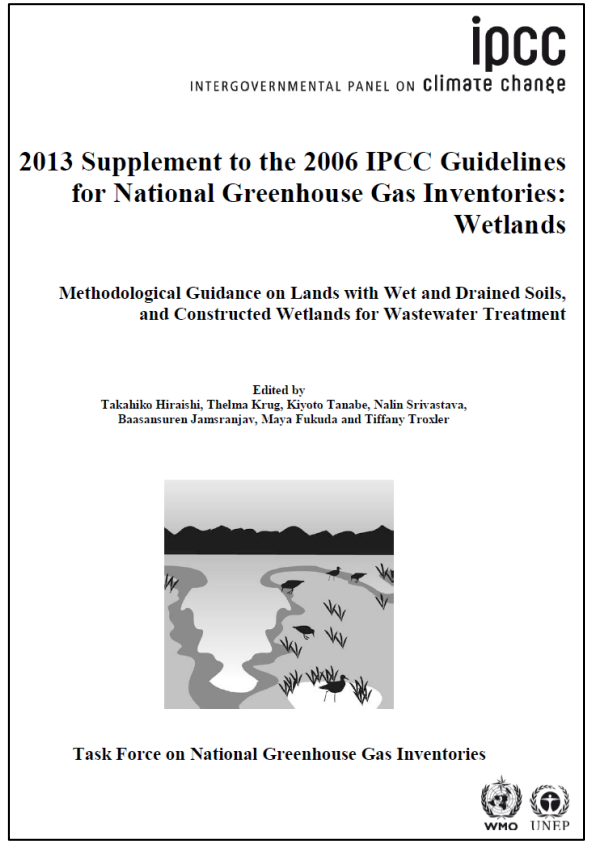
- Each annual submission involves a re-calculation of the whole inventory from 1990 onwards, taking into account inventory improvement activities
- Inventories are subject to annual expert review by international UNFCCC expert teams (Centralised and “In-Country” Reviews)

Impact of including IPCC Wetlands Supplement

(peatlands: 1990-2019 inventory)

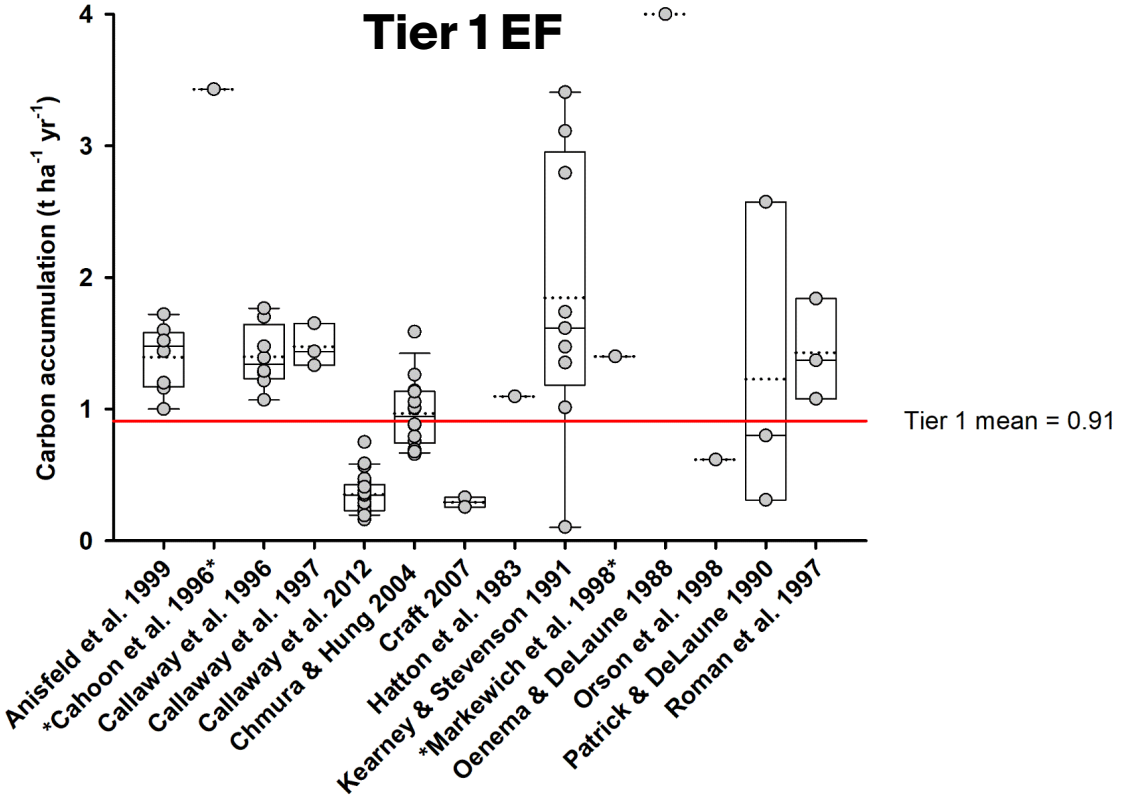
- Increased the area of organic soil reported, from **~500 kha** to **3,000 kha**.
- Impact of LULUCF recalculations on the 2019 inventory was **+16 Mt CO_2e**





Role of saltmarsh in Climate Change mitigation

- **Included under Land Use, Land-Use Change and Forestry (LULUCF)** in GHG inventories (IPCC Wetlands Supplement, 2014).
- Limited international reporting so far due to data gaps – **not in UK inventory.**



- Internationally agreed IPCC default (Tier 1) values for saltmarsh provide a **global average carbon accumulation** (C removal).
- Associated with the **re-establishment of saltmarsh vegetation**.

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Roadmap for potential inclusion of Saltmarsh in the UK GHGI

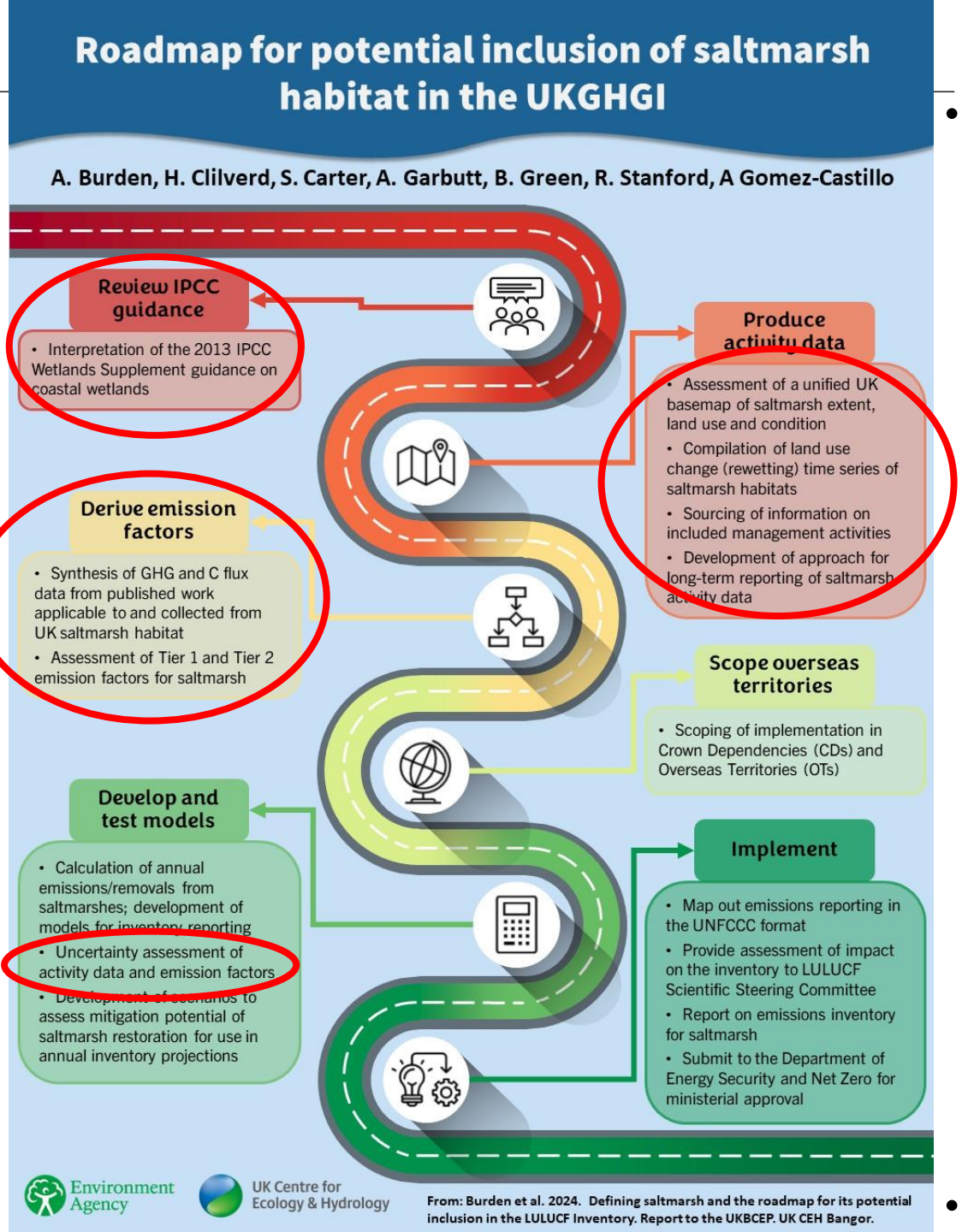
Taken from:

Burden et al. 2024. Defining saltmarsh and the roadmap for its potential inclusion in the LULUCF Inventory. Report to the UKBCEP. UK CEH Bangor.

https://randd.defra.gov.uk/ProjectDetails?ProjectId=21693

Environment Agency

Department for Environment Food & Rural Affairs



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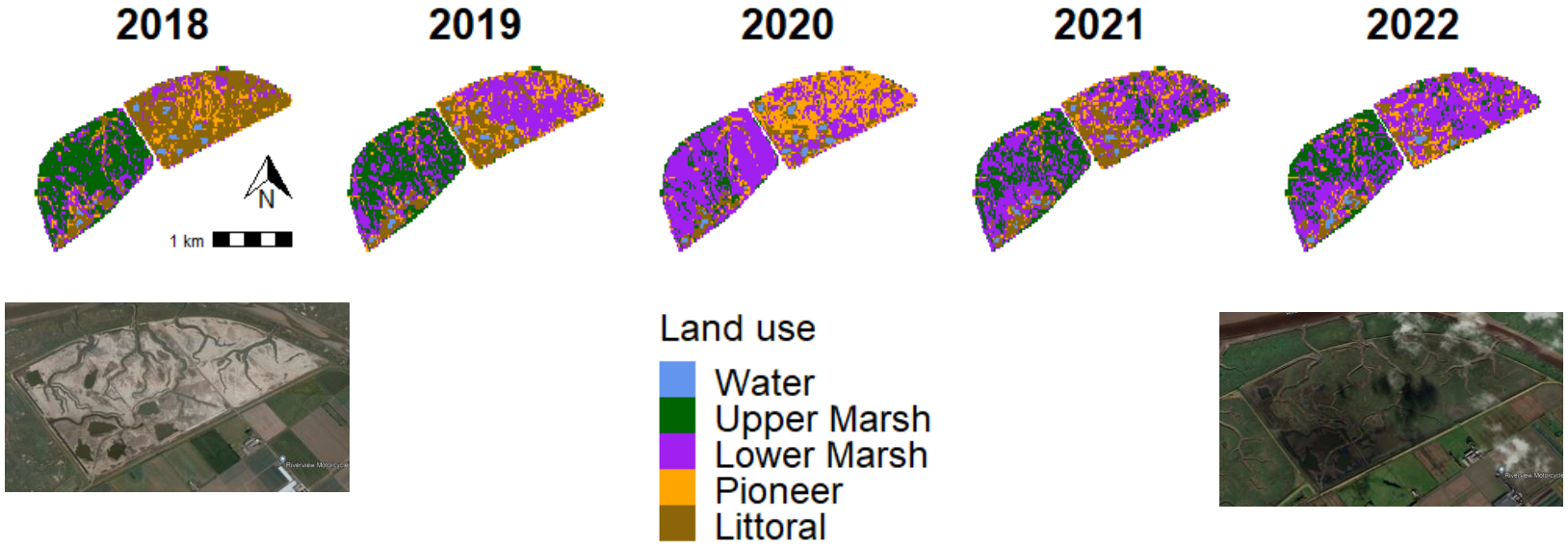
Produce activity data

Development of approach for long-term reporting of saltmarsh activity data

- **High model accuracy** for vegetated vs. bare soil classification (over 90% accuracy);
- 62% accuracy for differentiating between vegetated saltmarsh communities.



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Ecological Indicators
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Monitoring UK saltmarsh restoration using earth observation for national greenhouse gas accounting

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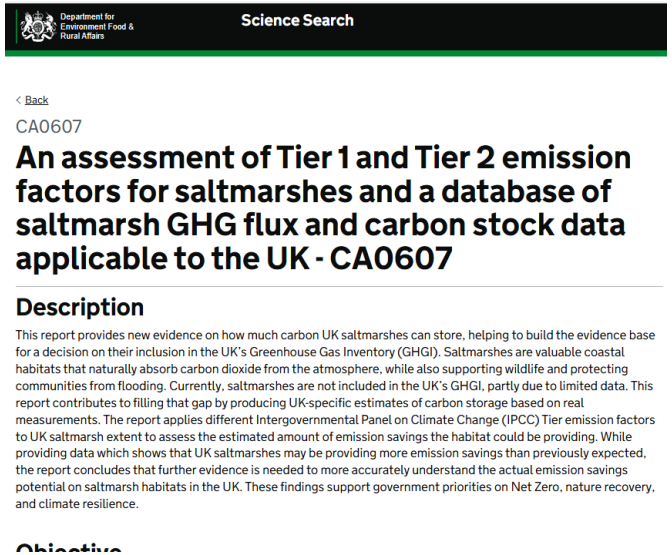
[b] UK Centre for Ecology & Hydrology, Deiniol Road, Bangor LL57 2UW, UK

Assessment of a unified UK basemap of saltmarsh extent, land use, and condition

→ Ongoing work

Developing UK-specific Emission Factors

- **Systematic review**
- **Population:** Saltmarsh habitat in the UK and temperate/northern European climatic zones.
- **Direct measurement**: GHGs, carbon stock, carbon content, burial, accumulation, accretion, indirect carbon gain/loss (POC, DOC).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Science Search

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CA0607

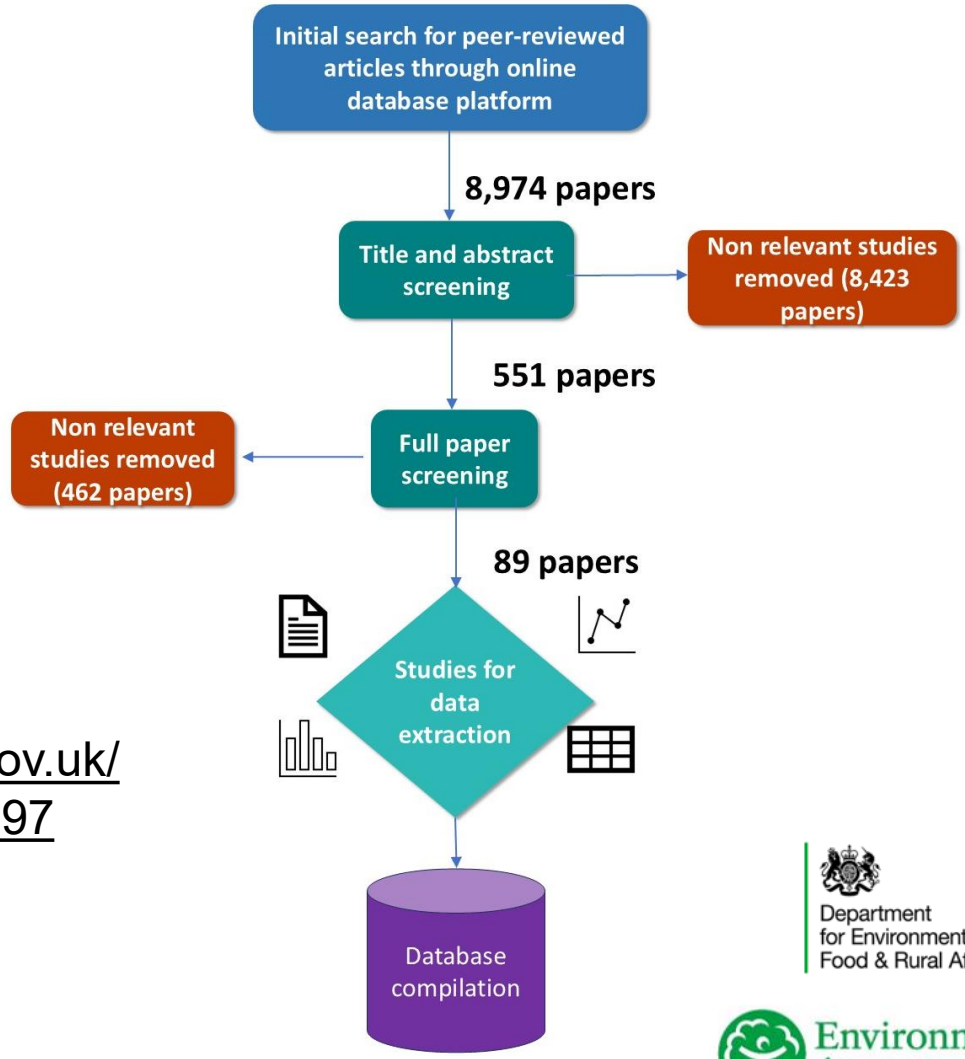
An assessment of Tier 1 and Tier 2 emission factors for saltmarshes and a database of saltmarsh GHG flux and carbon stock data applicable to the UK - CA0607

Description

This report provides new evidence on how much carbon UK saltmarshes can store, helping to build the evidence base for a decision on their inclusion in the UK's Greenhouse Gas Inventory (GHGI). Saltmarshes are valuable coastal habitats that naturally absorb carbon dioxide from the atmosphere, while also supporting wildlife and protecting communities from flooding. Currently, saltmarshes are not included in the UK's GHGI, partly due to limited data. This report contributes to filling that gap by producing UK-specific estimates of carbon storage based on real measurements. The report applies different Intergovernmental Panel on Climate Change (IPCC) Tier emission factors to UK saltmarsh extent to assess the estimated amount of emission savings the habitat could be providing. While providing data which shows that UK saltmarshes may be providing more emission savings than previously expected, the report concludes that further evidence is needed to more accurately understand the actual emission savings potential on saltmarsh habitats in the UK. These findings support government priorities on Net Zero, nature recovery, and climate resilience.

Objective

https://sciencesearch.defra.gov.uk/ProjectDetails?ProjectId=21897



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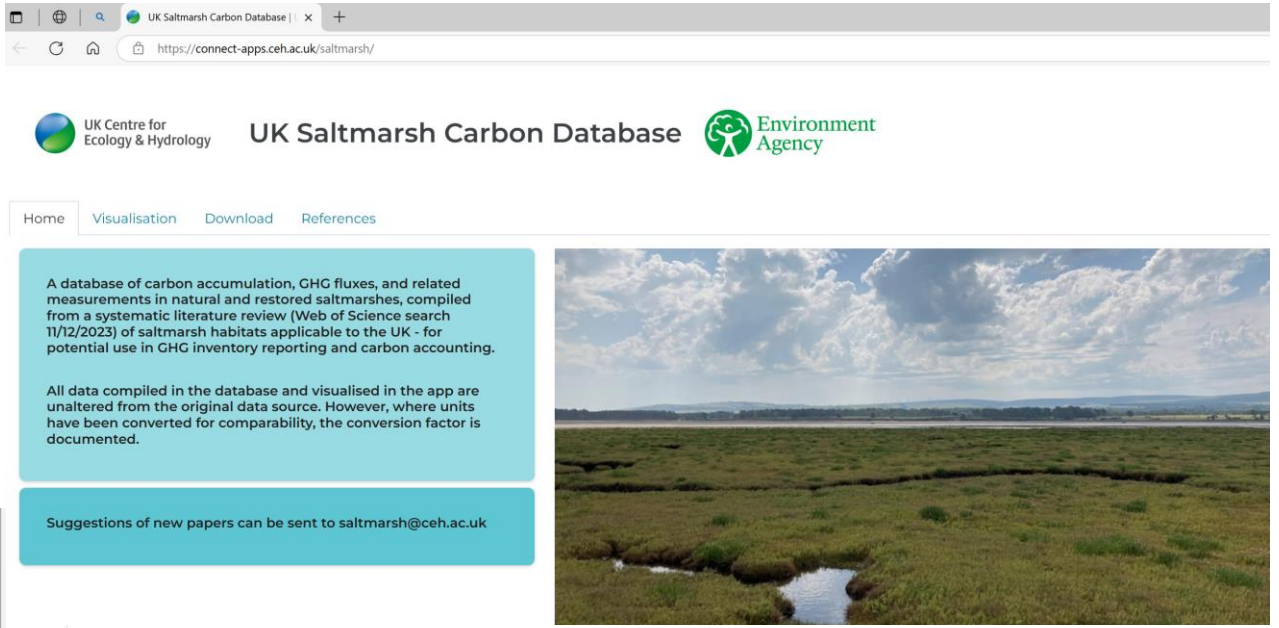
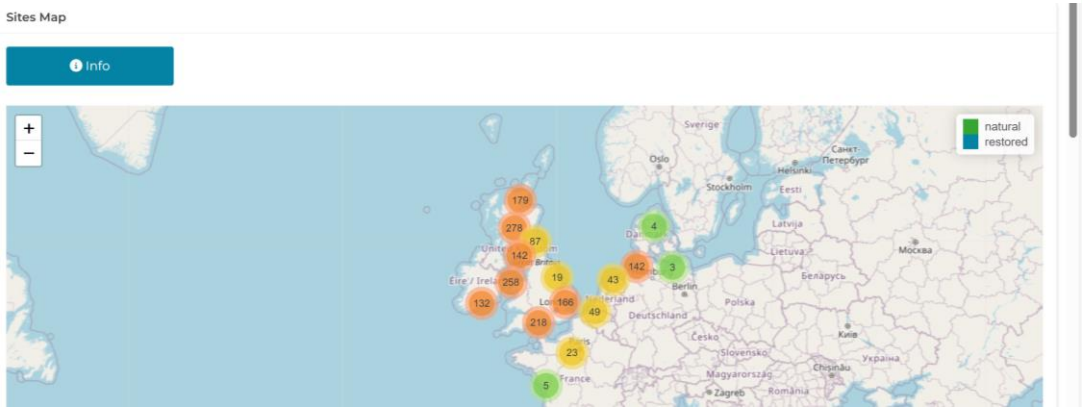
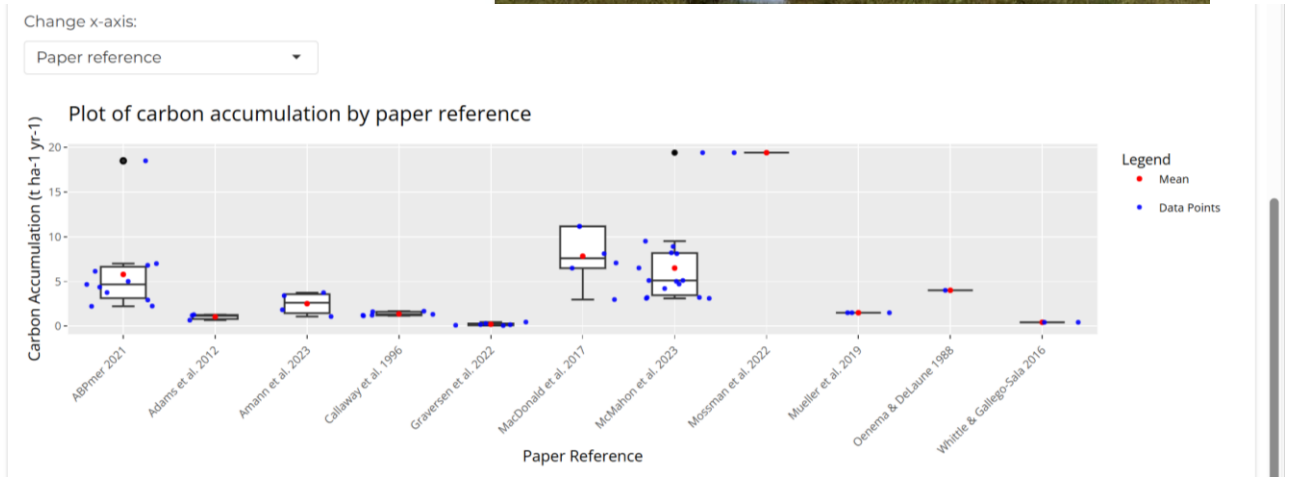
UK Saltmarsh Carbon Database

Synthesis of GHG and C flux data from published work applicable to and collected from UK saltmarsh habitat

Webtool is now live: https://connect-apps.ceh.ac.uk/saltmarsh/







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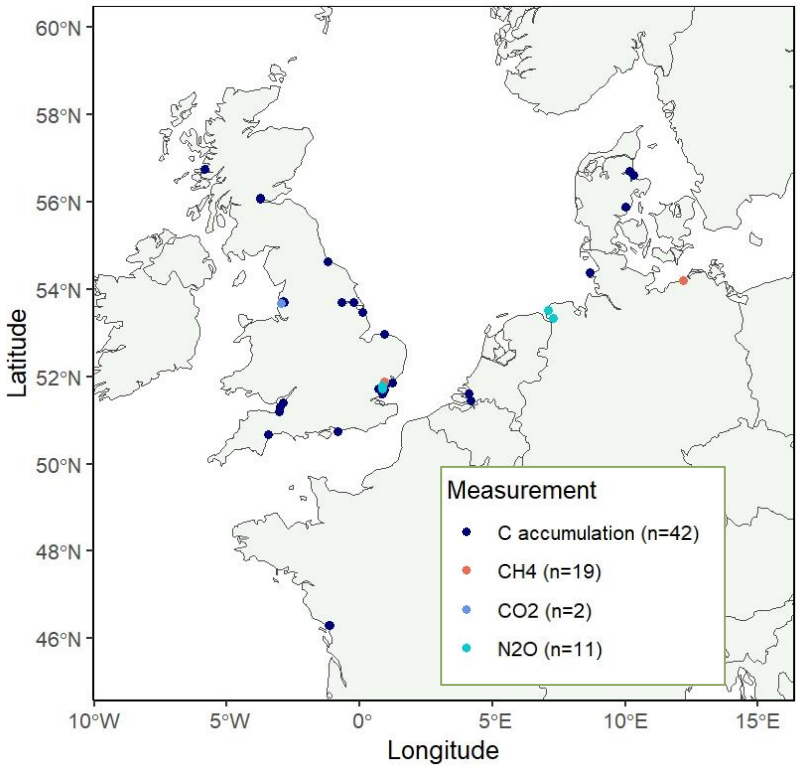
Steps in Emission Factor (EF) development



Data compilation – literature review

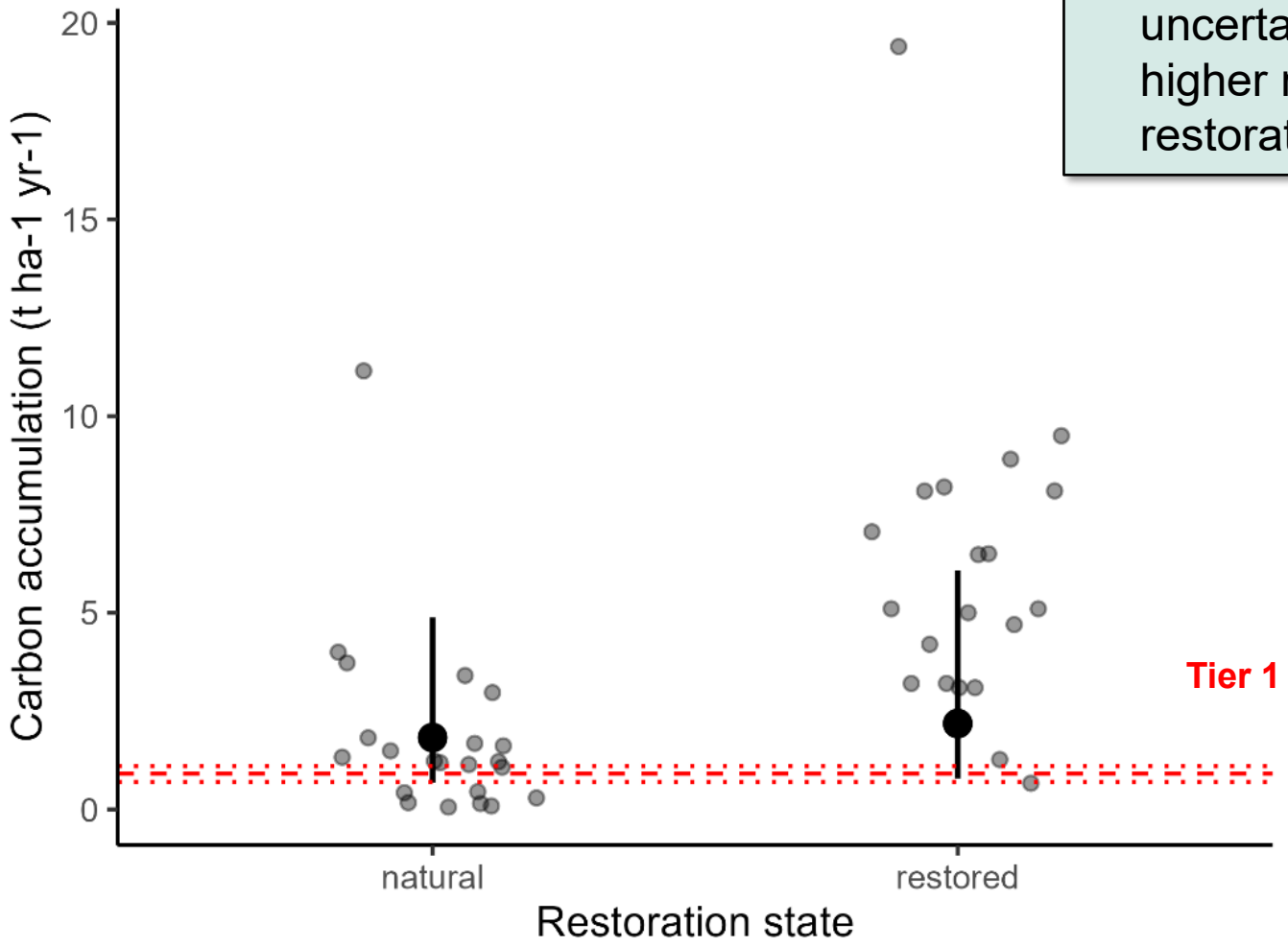
Visualisation - Histograms and boxplots for C accumulation, CH_4, CO_2, N_2O. Data sufficient for C accumulation and CH_4.

Distribution & uncertainty – Tested normal, log-normal, gamma distribution → log normal best

Model fitting - Generalised Linear Mixed Effect Models (GLMMs) – controlled for study and site

Sensitivity analysis – Compared Tier 1 EFs, tested outliers e.g. Steart data point (ultimately included)

Carbon EF



- Tier 2 Carbon Accumulation (natural): **-1.83 t C ha^{-1} yr^{-1}**
- **Higher values for restored saltmarshes**, but less confidence in a separate value due to uncertainties around the length of time a higher rate of accumulation persists following restoration.

CO_2 Flux

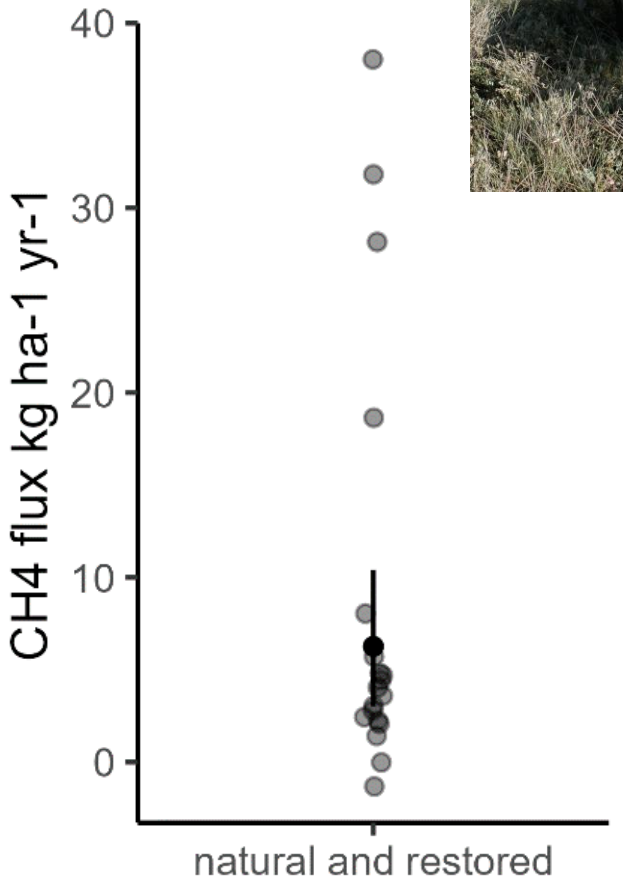
There are **just two data points for CO_2 flux**, from a natural saltmarsh in England. **Not enough to derive EF**.

Recommendations for improving data availability:

More studies could be included in the EF analysis if they had clearer documentation of methods (i.e., state measured vs modelled data) and reported values (and uncertainties) in data tables.

Methane EF

- Fluxes varied from **-1.34 to 38.00 kg CH_4 ha^{-1} yr^{-1}.**
- Only one data point from a restored site (Adams et al., 2012).
- Not possible to derive a separate Tier 2 CH_4 flux value for natural and restored saltmarshes.
- Instead, a **combined emission factor was calculated**.
- Tier 2 Methane: **6.26 kg CH_4 ha^{-1} yr^{-1}**, (95% CI does not overlap zero).



N_2O Flux

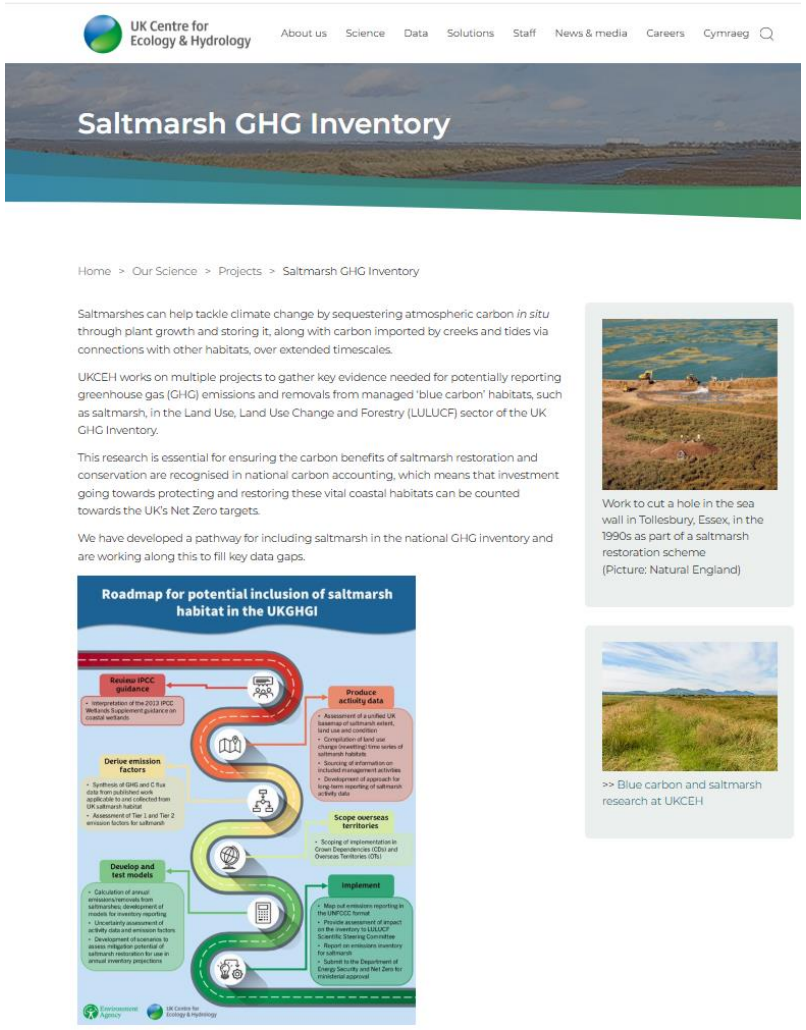
Only two studies included measures of N_2O fluxes from saltmarsh in Europe – EF cannot be derived from this.

Key Results

- We have been able to calculate Tier 2 EFs for UK saltmarshes, which offer **improved representation for UK conditions**.
- UK saltmarshes are calculated to be a **Net Sink**: **-6.53 t CO_2e ha^{-1} yr^{-1} (CI: -2.41, -17.60)** (Carbon accumulation > methane source)**.**
- Tier 1 values estimate: **-3.34 t CO_2e ha^{-1} yr^{-1} (CI: -2.57, -4.03).**
- Represents a **sink of 329 kt CO_2e yr^{-1}** (vs 168 kt under Tier 1) for the estimated extent of natural and restored UK saltmarsh (~50 kha).
- <u>Future work:</u>
  - Wide confidence intervals in the estimated Tier 2 EFs, more data would reduce these particularly direct measures of C accumulation and long-term field measurements GHG fluxes.
  - Further research needed to determine the length of time the higher carbon accumulation rate for restored marshes would be applicable (most restored saltmarsh data from sites <20 years old).

New UKCEH Saltmarsh GHGI webpage

https://www.ceh.ac.uk/our-science/projects/saltmarsh-ghg-inventory



> Saltmarshes are intertidal areas that generally **occur between** (but are not restricted to) **mean high-water spring tides** and **mean high-water neap tides** (with transitional elements to Highest Astronomical Tide) at temperate latitudes and are colonised by **halophytic flora**. However, the position of saltmarsh is context dependent, and variations around this 'rule of thumb' occur.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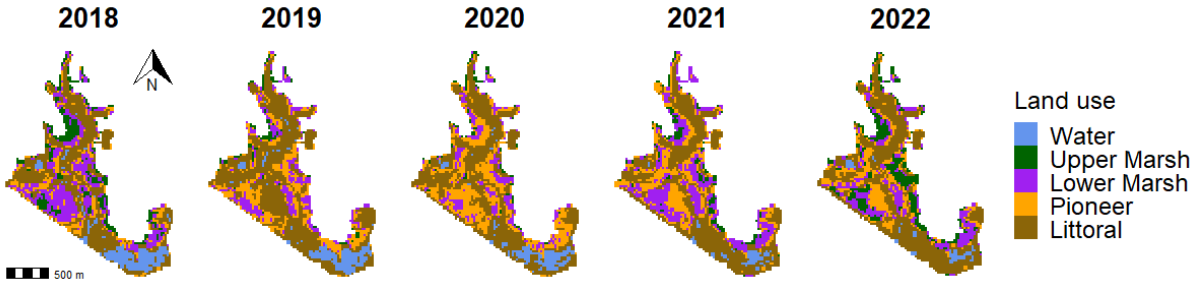

EO-derived time series of mapped vegetation change (bare to colonised) on rewetted saltmarsh at Medmerry, England.

Thank you.

For more information please contact:

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Hannah Clilverd: hanilv@ceh.ac.uk

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