LAND USE *for* NET ZERO HUB

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Landscape-scale management and decision making

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UK Research and Innovation

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Department for Energy Security & Net Zero

Llywodraeth Cymru Welsh Government

Scottish Government Riaghaltas na h-Alba

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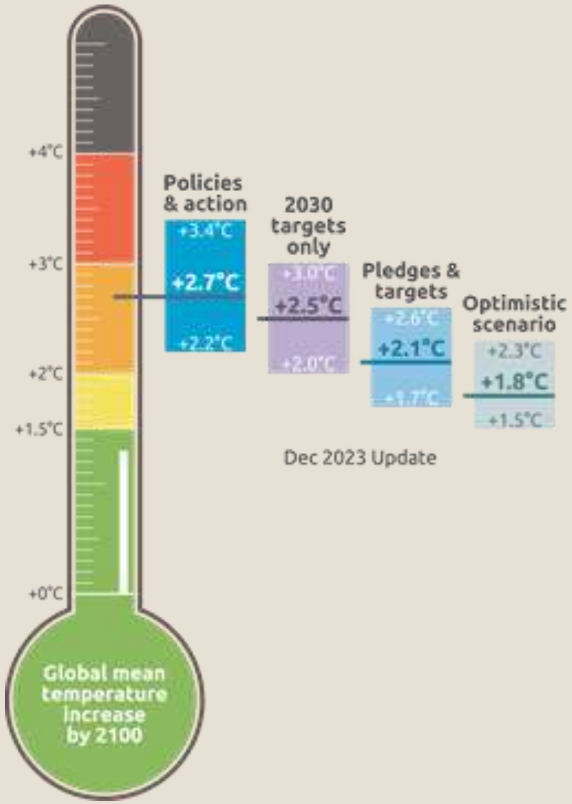
Overshoot

- In Paris in 2015, the world agreed to **limit global warming** to well below +2 °C and to pursue efforts to limit it to +1.5 °C above pre-industrial levels.
- **“Climate overshoot”** means crossing the +1.5 °C threshold.
- In April 2022 the IPCC said that *“it is almost inevitable that we will temporarily exceed this [+1.5 °C] temperature threshold but could return to below it by the end of the century.”*
- The **first 12-month period to exceed 1.5°C** as an average was February 2023 – January 2024, boosted by El Niño, according to the Copernicus Climate Change Service.



Climate Action Tracker

TRACKING GLOBAL CLIMATE ACTION SINCE 2009

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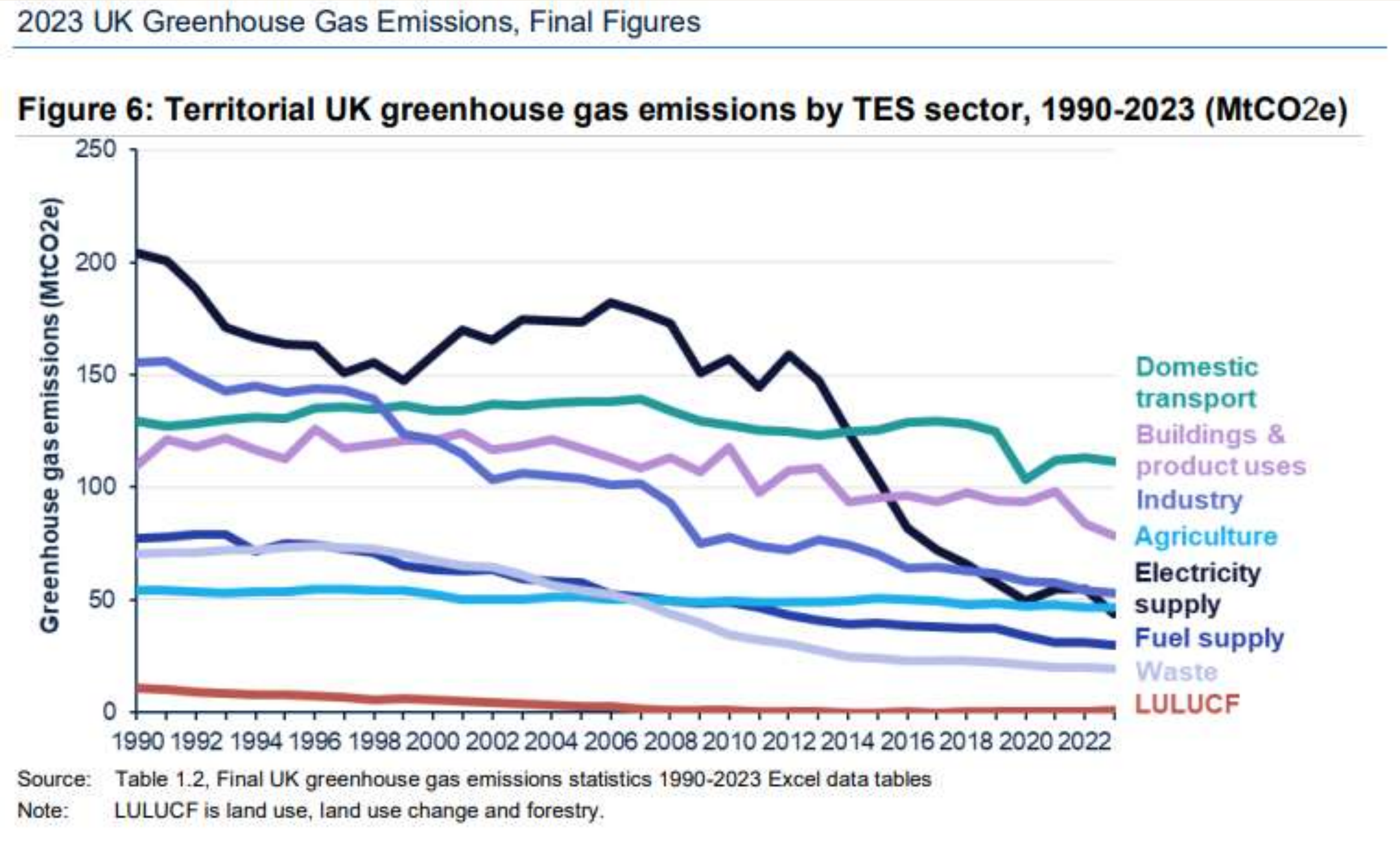
UK GHG emissions by sector



- The UK has made good progress with its emission reductions.
- But there is still some way to go: All the easy wins have been realised already.
- Landscape management is key to reducing the stubborn emissions from Agriculture and LULUCF, in particular.

Source: DESNZ (2023)
https://assets.publishing.service.gov.uk/media/67a30e4f7da1f1ac64e5feb1/2023-final-greenhouse-gas-emissions-statistical-release.pdf

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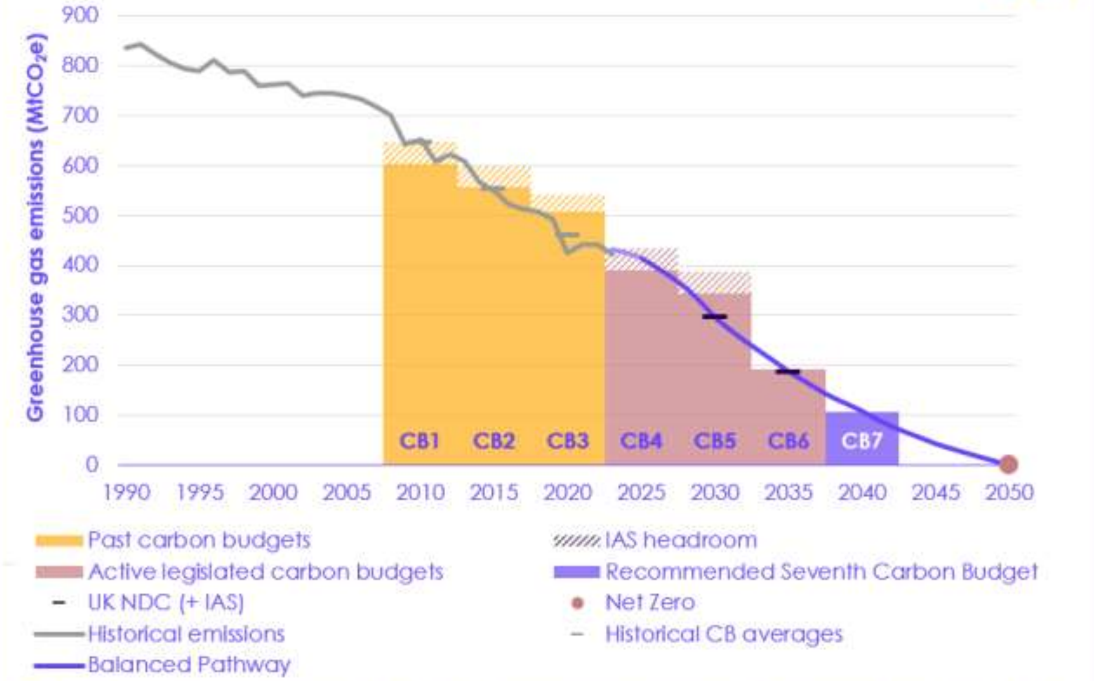
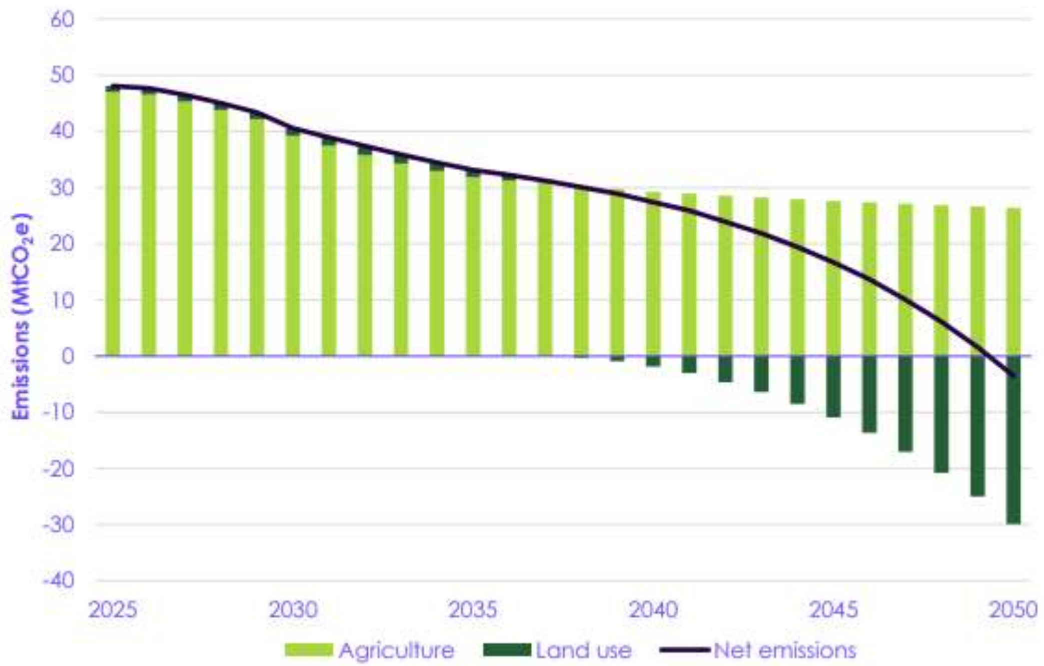
UK Carbon Budget 7

Figure 1 The recommended Seventh Carbon Budget



Description: The Balanced Pathway meets the UK's existing future emissions targets and sets the recommended level for the UK's next target: the Seventh Carbon Budget.
Source: Department for Energy Security and Net Zero (DESNZ) (2024) *Provisional UK greenhouse gas emissions national statistics 2023*; DESNZ (2024) *Final UK greenhouse gas emissions national statistics: 1990 to 2022*; Climate Change Committee (CCC) analysis.
Notes: See Chapter 3. 'CB' refers to the UK's carbon budget. 'CB1' refers to the First Carbon Budget; subsequent numbers refer to subsequent carbon budgets. 'IAS' refers to international aviation and shipping. 'UK NDC' refers to the UK's Nationally Determined Contributions.

Figure 7.4.3 Net emissions in the agriculture and land use sectors in the Balanced Pathway



Description: Emissions associated with the combined agriculture and land use sectors fall steadily throughout the pathway until they become approximately Net Zero in 2050, due to the rapid increase in land-based sequestration in the 2040s. Agriculture remains a net source, with emissions plateauing from 2040.
Source: UK Centre for Ecology and Hydrology (2025); CCC analysis.

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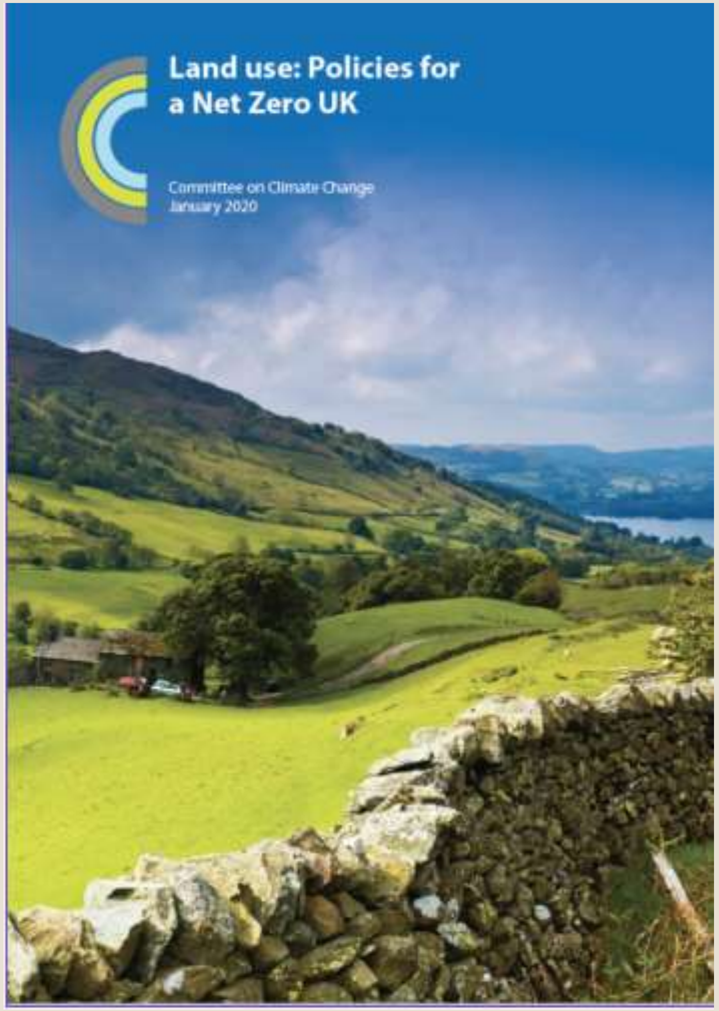
Agriculture is currently the fourth-highest emitting sector in the UK. By 2040, it will account for 27% of UK GHG emissions and will be the UK's second highest-emitting sector.

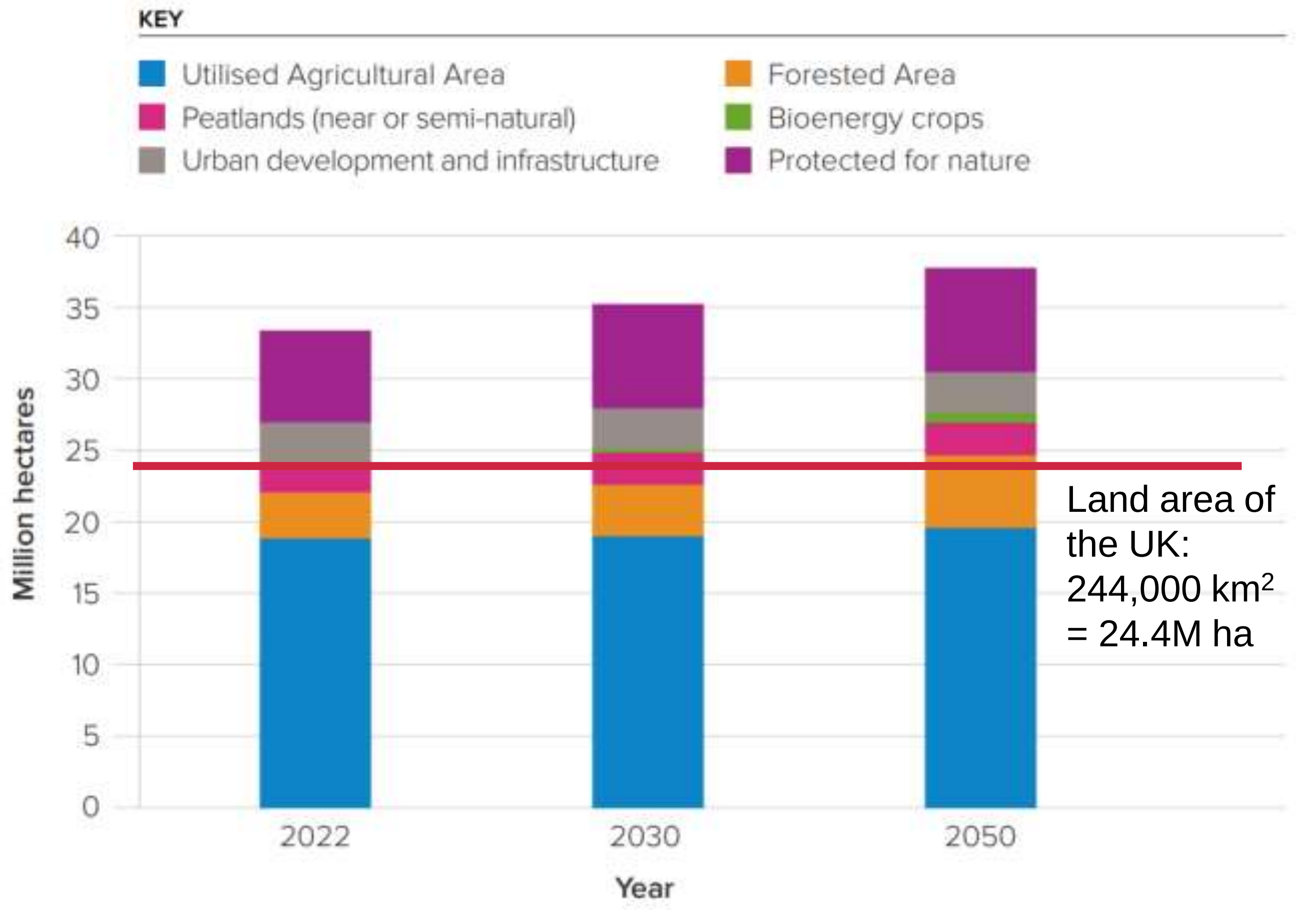
Committee on Climate Change: Land Use Policy Recommendations



Why multifunctional landscapes are crucial

Policy goals require that land achieves multiple objectives in the same area. Otherwise we do not have enough land.

Policy commitments are: increase woodland cover to 14.8% of UK land area by 2030 and 17% by 2050[33, 34, 35, 36]; restore 300,000 ha peatland by 2050[37, 38, 39]; scale up bioenergy crop production to 23,000 ha per year by mid-2020s; protect 30% of land for nature by 2030[40, 41, 42, 43]. Agricultural output is calculated as a function of population projections[44].



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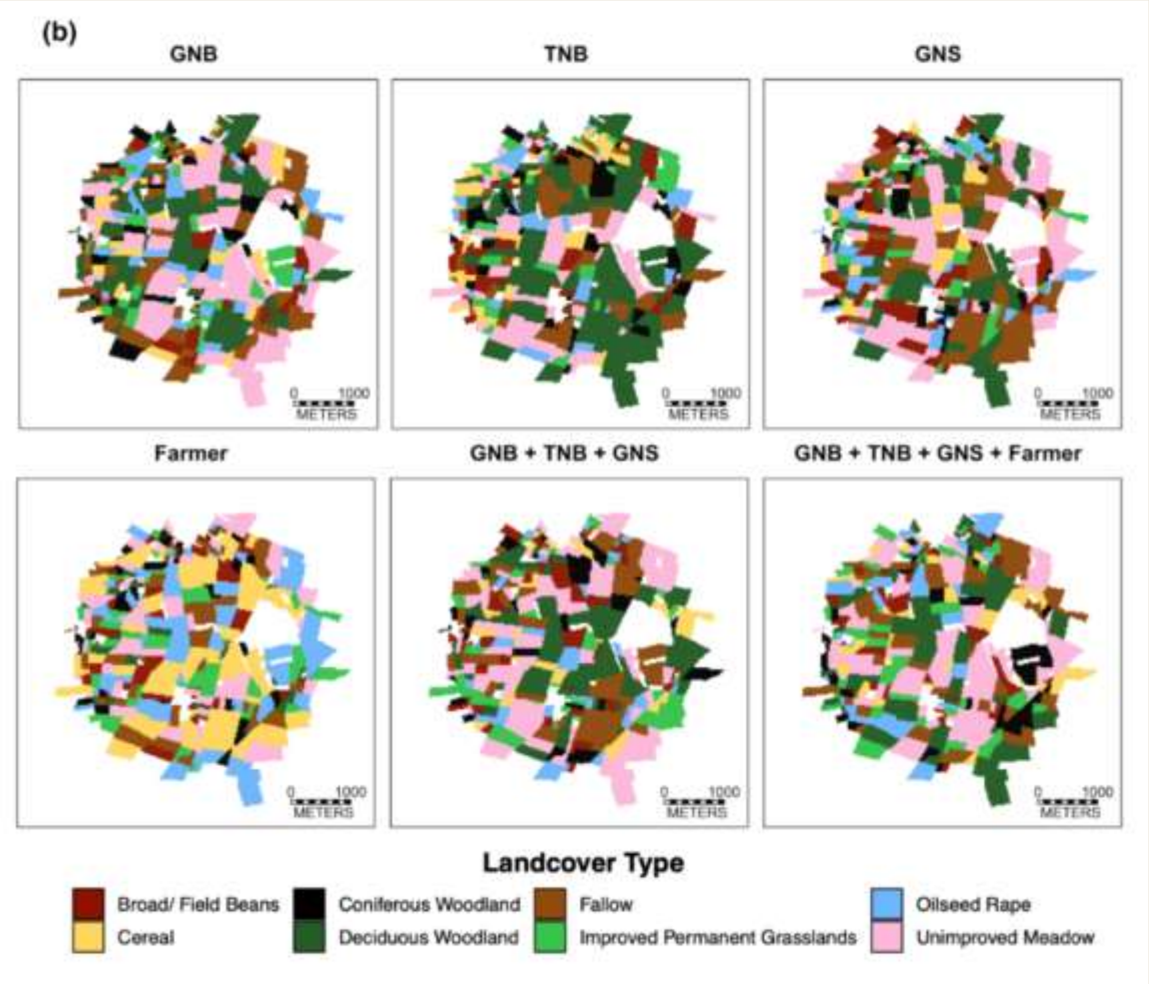
Multifunctional landscapes for climate, nature and people

- Multi-objective optimisation results in significantly different optimal landscape configurations.
- Guilds of species need to be considered separately, rather than an overall biodiversity metric, to avoid biasing towards human needs.
- Participatory approaches with multiple stakeholders are better at delivering acceptable land use scenarios.




Received: 2 April 2024 | Accepted: 23 August 2024
DOI: 10.1111/2041-210X.14424
Methods in Ecology and Evolution

RESEARCH ARTICLE

Adapting genetic algorithms for multifunctional landscape decisions: A theoretical case study on wild bees and farmers in the UK

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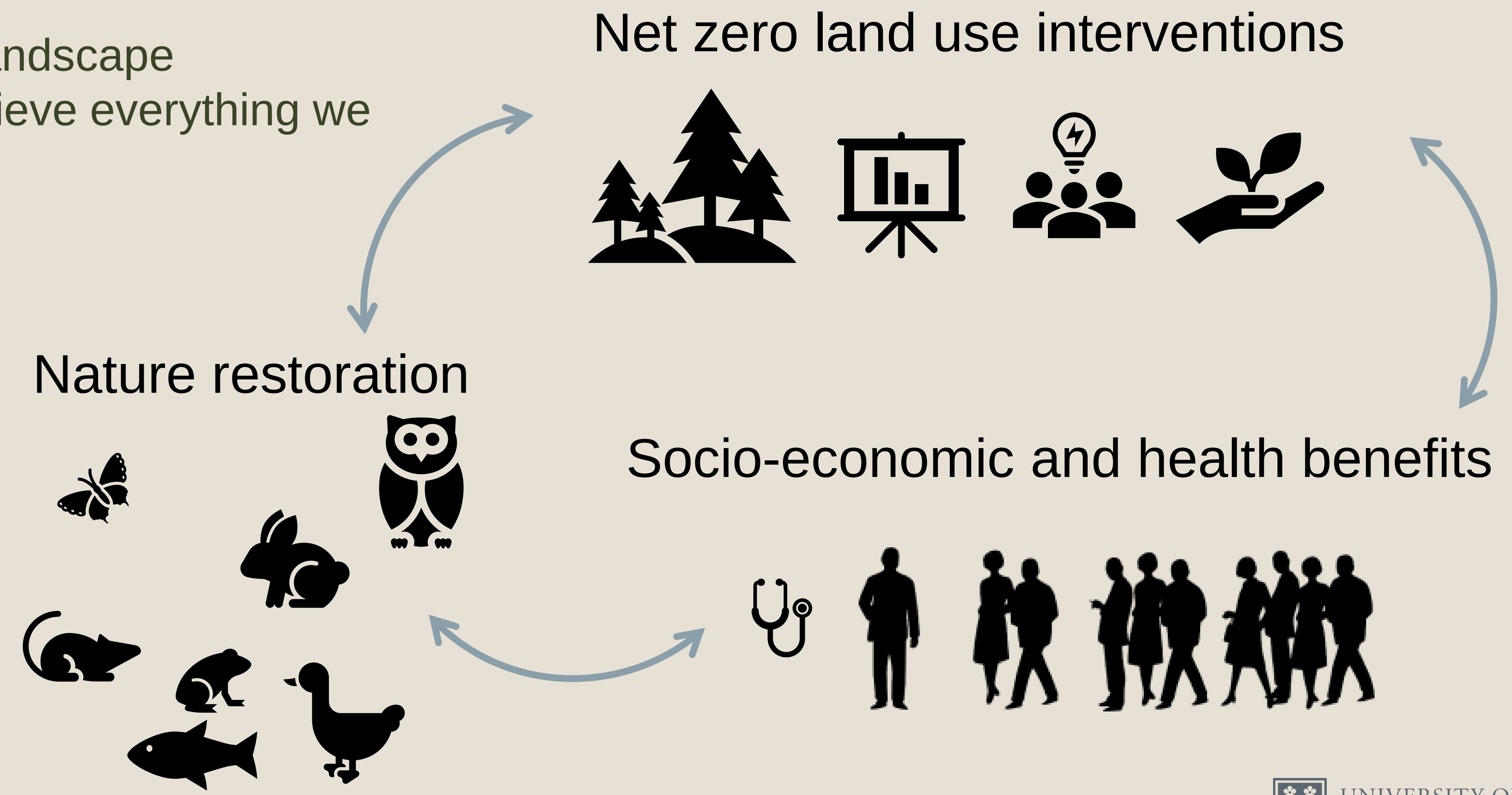
COP29 Baku Azerbaijan

Co-benefits of multifunctional landscapes

- Land use interventions towards net zero emissions should consider co-benefits and trade-offs with other policy goals.
- Only multifunctional landscape management can achieve everything we want.



Peatlands in Carbon Budget 7

Over half of land use emissions reductions by 2040 need to come from peatlands.

Peatland restoration and management can deliver 17% of emissions reduction by 2040.

The area of UK peatlands in natural or rewetted condition needs to double by 2040.

- Restoration of upland peatlands and forested peats (5%).
  - Restoration of upland blanket bogs to near-natural state needs to rise from 30% to 60% by 2040.
- Restoration and management of lowland peatlands (12%).
  - Restoration of lowland peatlands needs to rise from 9% to 31% by 2040.
  - Paludiculture and water level management allow continued agricultural use with reduced emissions on 4% of lowland peatlands by 2040, rising to 10% by 2050.

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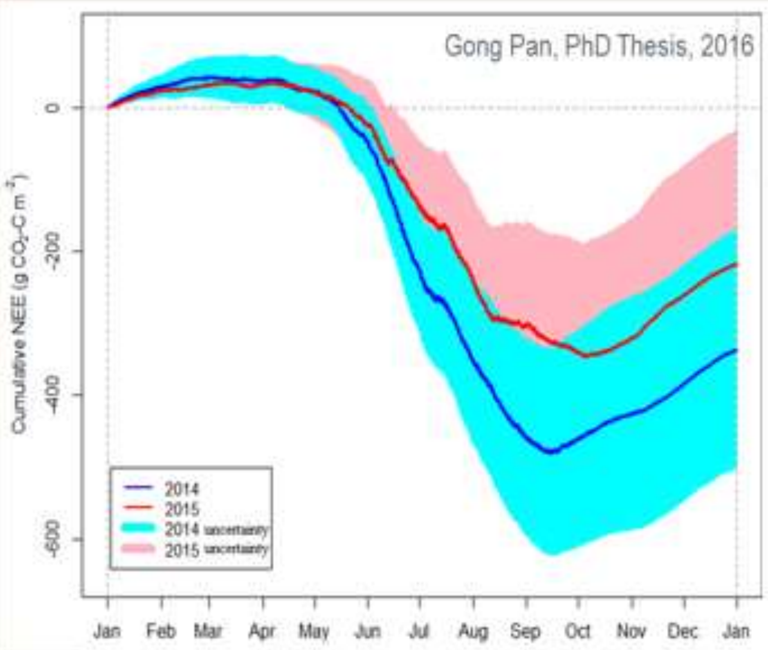
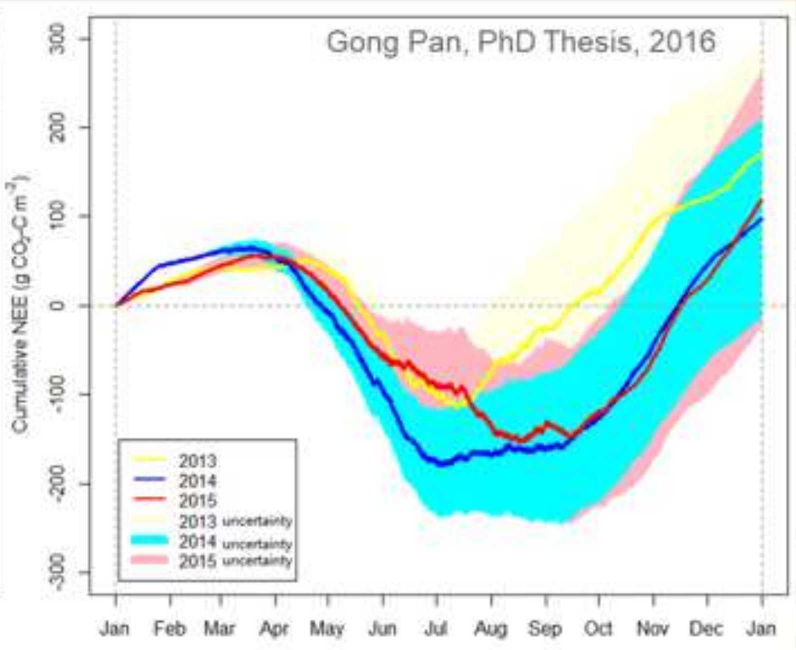
CO_2 emissions from three peatland sites

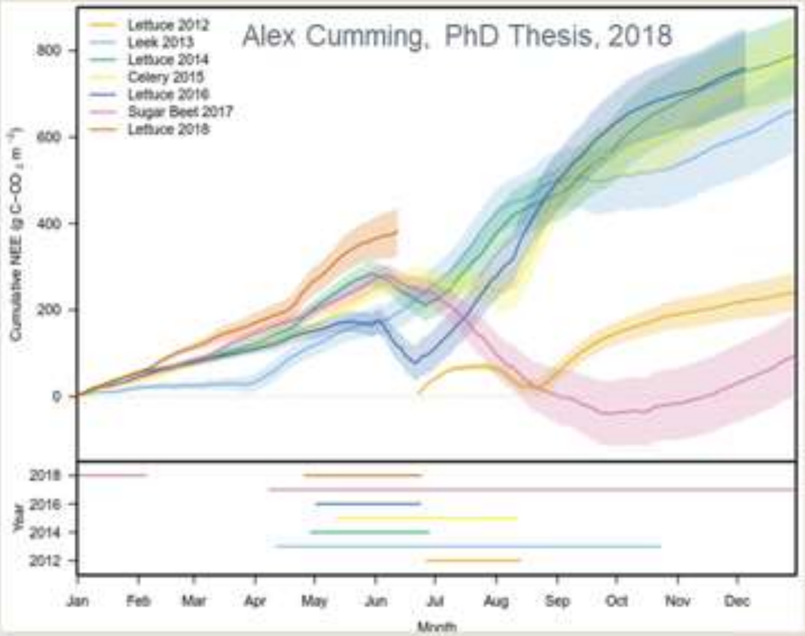
Semi-natural Fen: Sedge Fen
CO_2 sink (-300gC $m^{-2}yr^{-1}$)

| **Restoring Fen: Baker's Fen**
| CO_2 source (314gC $m^{-2}yr^{-1}$)

| **Agricultural Fen: Rosedene**
| large CO_2 source (760gC $m^{-2}yr^{-1}$)







Credit: Jörg Kaduk

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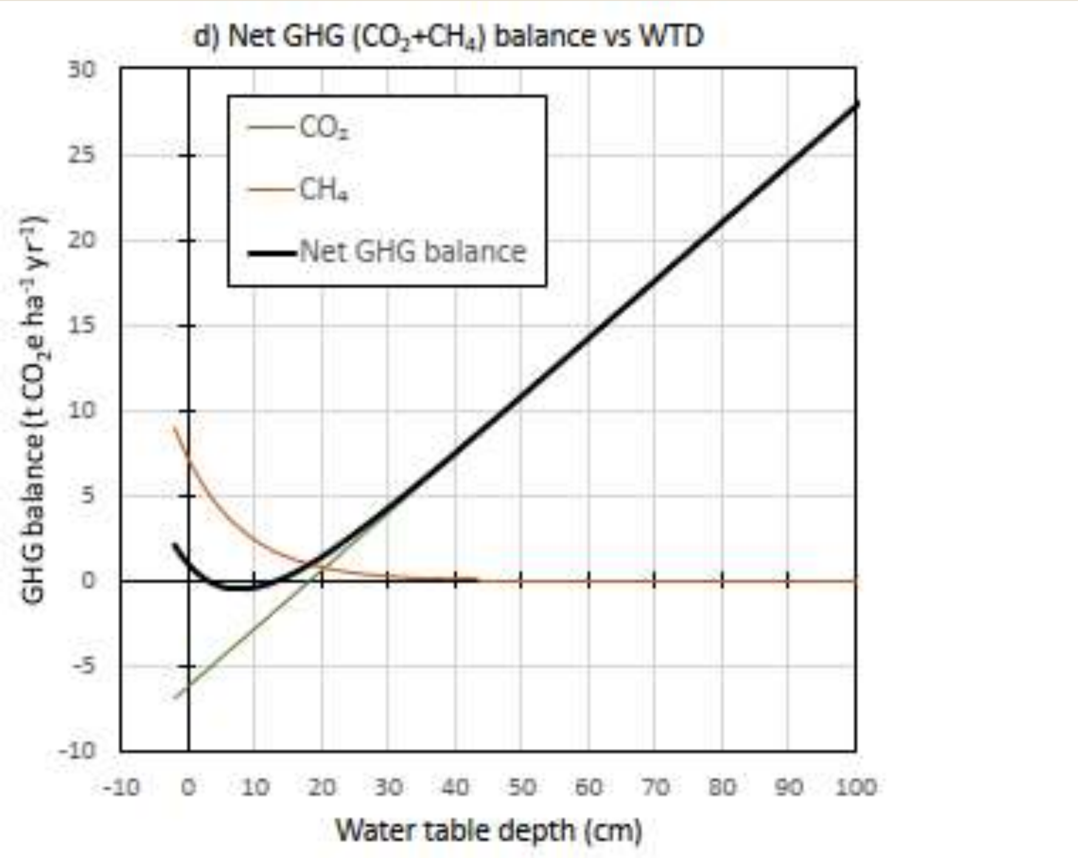
Water table effect on peatland emissions



10 cm mean water table depth is the sweet spot with overall lowest greenhouse gas emissions (methane and carbon dioxide).

Figure: Annual mean greenhouse gas fluxes as a function of mean water table depth. Source: Evans, C.D., Peacock, M., Baird, A.J. *et al.* Overriding water table control on managed peatland greenhouse gas emissions. *Nature* **593**, 548–552 (2021). https://doi.org/10.1038/s41586-021-03523-1

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Digital twins

- Digital twins can provide information to farmers how they can reduce greenhouse gas emissions by choosing different land management options.
- This digital twin is powered by satellite imagery, flux tower data, the JULES-CROP land surface model and machine learning.
- It predicts CO_2 fluxes at field scale on lowland peat used for agriculture for different crops.

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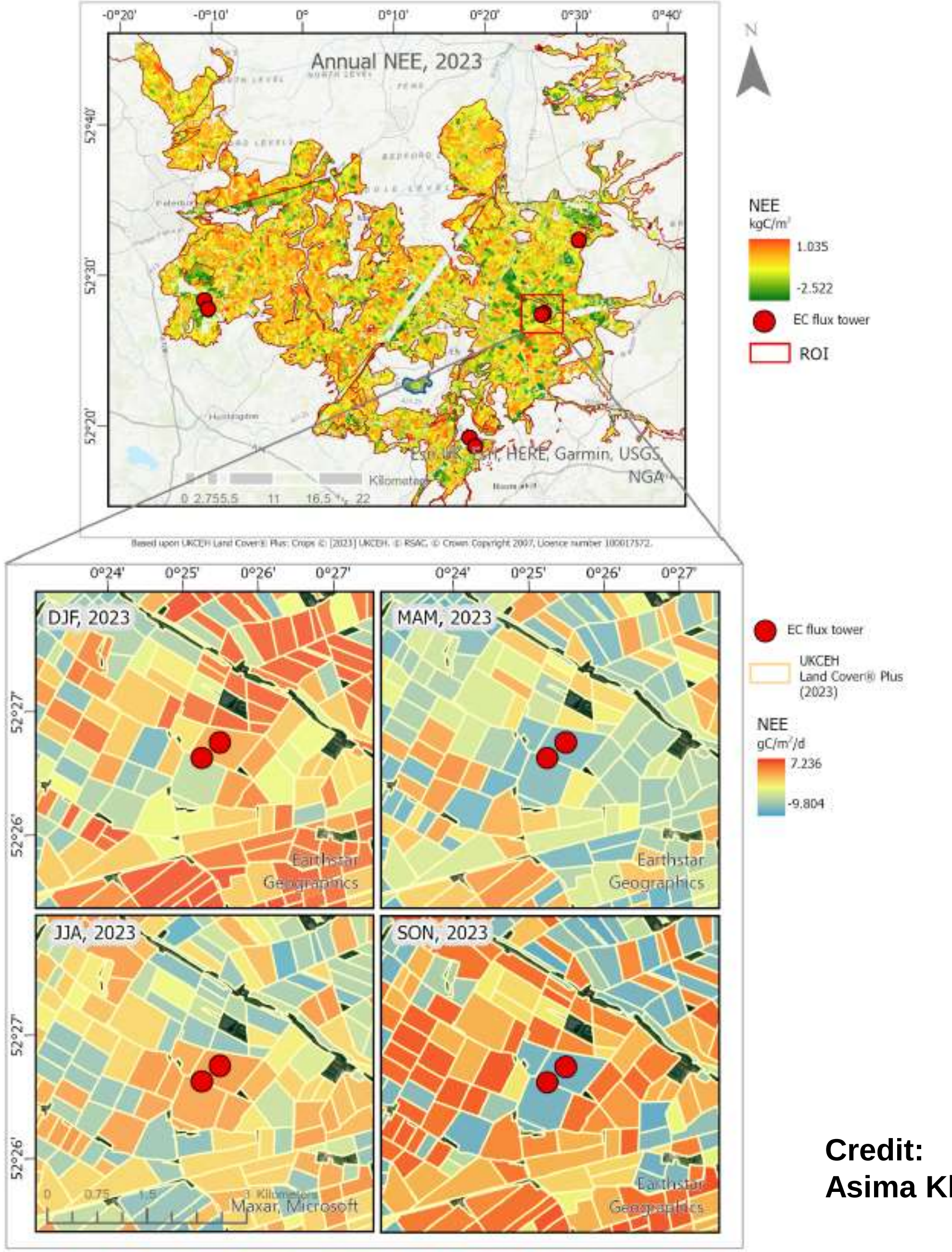

Figure 7: Shows the upscaled per field annual NEE kgC/m^2 for the year 2023 across the drained peatlands of East Anglia (top) and average seasonal NEE (gC/m^2/d) around two cropland flux tower sites (Redmere 1 and 2) (below). DJF = Dec-Jan-Feb; MAM= Mar-Apr-May; JJA=Jun-Jul-Aug; SON=Sep-Oct-Nov. The extent of peatlands in the area is based on Peaty Soils Location map by BGS, NSRI and OS.

Credit: Asima Khan

Key recommendations by the Landscape Decisions Programme

- Invest in transdisciplinary approaches for landscape management decisions,
- Ensure the right ecosystem is promoted in the right place (no single land-use solution should be prioritised above others),
- Increase local and devolved decision making capabilities.

Cole, B., Saratsi, EE., Earnshaw, K., Willcock, S., Gardner, E., Bradley, A. et al. (2022). **Making Landscape Decisions to Meet Net Zero Carbon: Pathways that consider ethics, socio-ecological diversity, and landscape functions.** University of Leicester. Report. https://doi.org/10.25392/leicester.data.19011629.v2

The LUNZ Hub team – values driven

- Transdisciplinary
- Evidence based
- Practical application
- Walking the talk
- Celebrating success

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