National Tree Hedgerow and Woodland (THaW) mapping for Net Zero.

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1 Mapping the Treescape - THaW

The Tree Hedgerow and Woodland (THaW) mapping data have been produced for England and Wales. Data are generated using LiDAR data from the National LiDAR Program dataset following methods set out in Luscombe et al. (2023)[(2)].

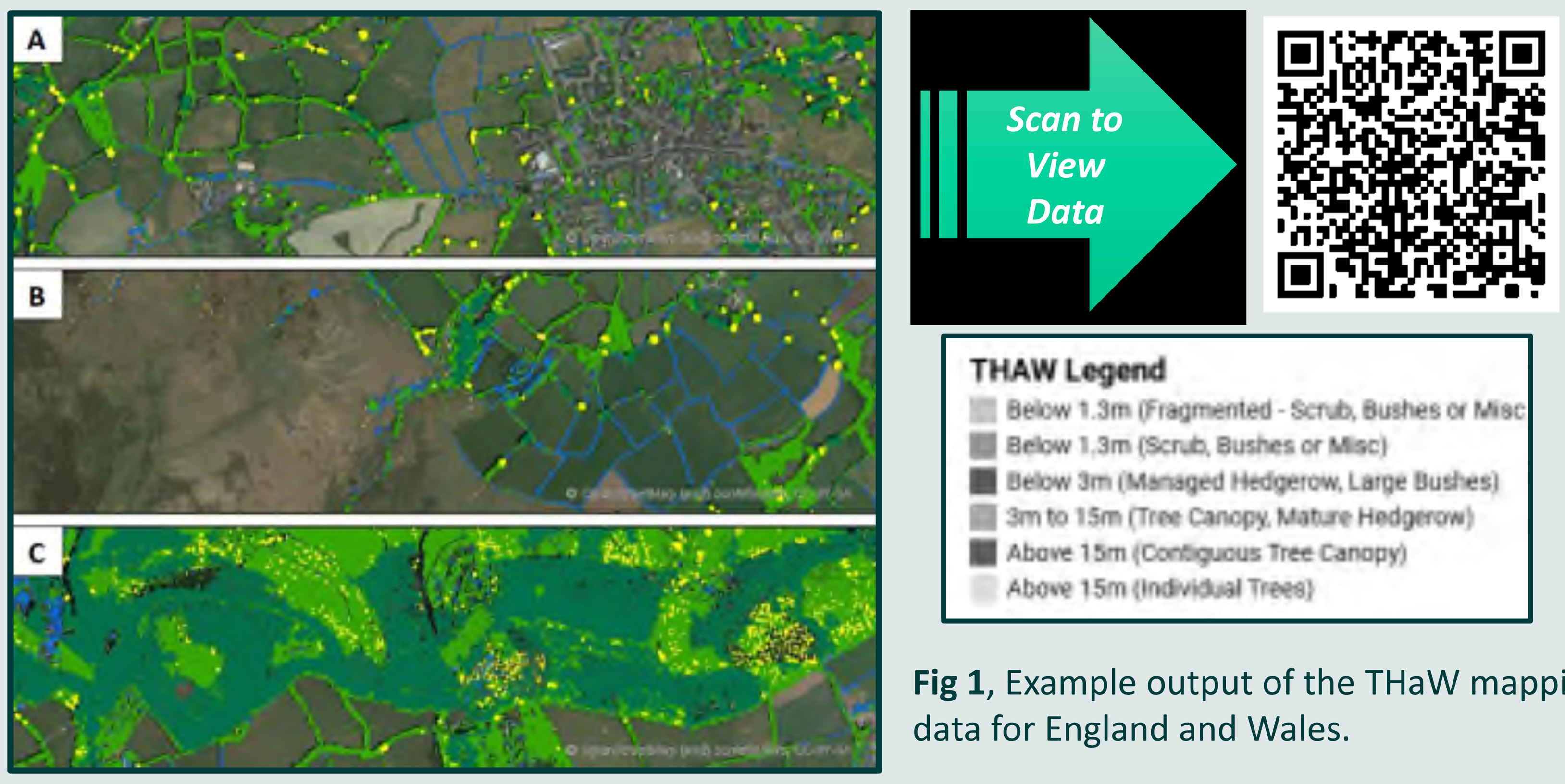

Fig 1, Example output of the THaW mapping data for England and Wales.

This fine-grained (1m² per pixel) national inventory of trees, hedgerows and woodlands (THaW) can structurally classify and quantify above-ground carbon in living biomass across the 130k km² of England. These data illustrate a total THaW carbon stock of >362 million tonnes in England, almost half of which (49%) is contributed by broadleaf tree canopies (canopy height 3 -15 m), some of which forms linear woody features such as hedgerows. The mature broadleaf canopy with height >15 m contributes 27% whilst conifers account for 10% of THaW landscape carbon (<2% more than all hedgerows combined).

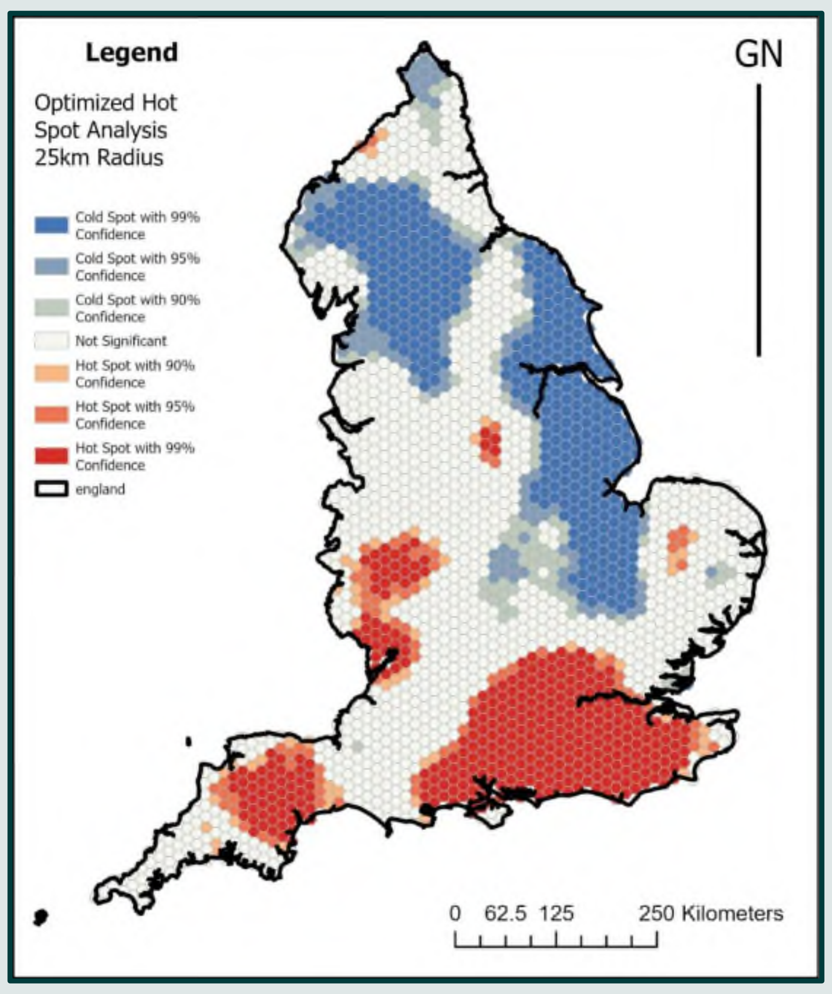

Fig 2, Tree Hedgerow and Woodland carbon stock hotspots across England. Hotspots of THaW carbon stocks are dominant in southerly areas of England; whilst the north-east and north-west have comparatively less THaW carbon.

2 Hedgerow Condition Mapping

Using Tree Hedgerow and Woodland (THaW) data for the whole of England, generated from the UK government national lidar programme, we have developed an automatic protocol to classify the management condition of hedgerow structures.

- The hedgerow network was segmented by identifying "narrow" or "non-narrow" sections (ArcGIS Pro 3.1.2).
- Hedgerow condition was derived from numerically separating the two-dimensional geometry (area, length, width) of features identified as hedgerows and deriving ratios of these metrics. Data were numerically classified and resultant classes were mapped to the hedgerow management classes identified in the "Adams Hedgerow Management Scale[3]".
- Preliminary work to assess the correspondence of the mapped data to existing indices of habitat connectivity (Fig 3) demonstrate a substantial difference in connectivity between the identified management classes.

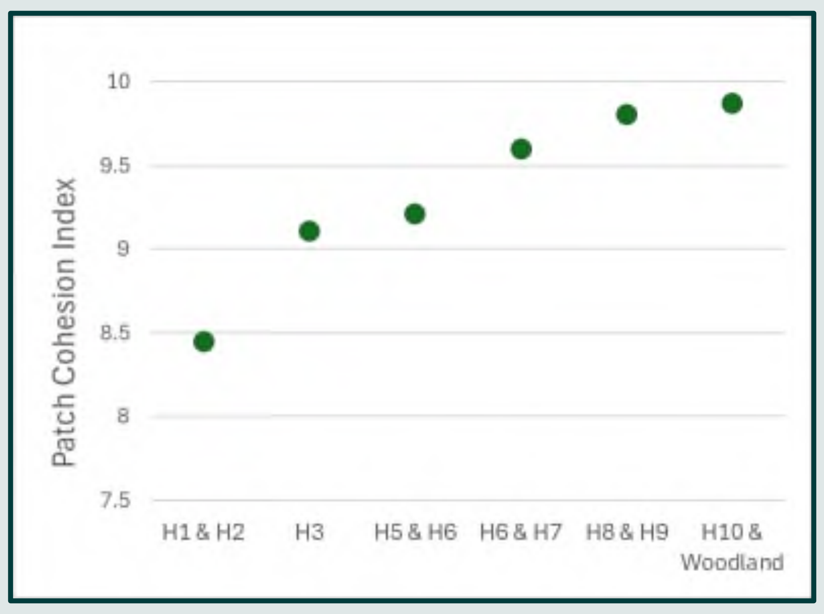

Fig 3, (above) The relevant (landscape) patch cohesion Index derived for each of the mapped management classes. Data demonstrate a significantly reduced habitat connectivity in the most heavily managed hedgerow classes.

Fig 4, (left) Hedgerow management classes taken from the Adams Hedgerow Management Scale[3], colour coded (boxes) alongside examples of extracted hedgerow classes.

3 Decadal Spatial Change Detection of THaW

We produced an online machine learning tool that can generate instantaneous maps of Tree and Woodland (TaW) distribution from contemporary Synthetic Aperture RADAR data (ESA Sentinel 1 SAR) for any location in England and Wales. This method uses machine learning approaches trained on LiDAR derived THaW mapping data. Output data produce both contemporary maps of THaW cover extent, and decadal change maps of past THaW distribution. These decadal change maps are optimised to produce annual outputs displayed as persistence maps of THaW in the landscape, presented as spatial change vector maps (fig 5), where every pixel of calculated change has a two-dimensional vector assigned to indicate the speed of canopy loss or gain at any location.

Data Preparation:

- Sentinel-1 VH-polarization composites (2015–2024), filtered and aggregated by year (median)

Random Forest Classifier (Smile), trained using LiDAR derived THaW data (2019):

- 2,000 stratified points (balanced tree/non-tree)
- 80% train / 20% test split

Model Parameters:

- 100 decision trees
- Input: Sentinel-1 VH backscatter
- Output: Tree (1) / Non-tree (0) classification

Validation:

Overall Accuracy	82%
User's Accuracy	84%

Time Series Classification

- Annual classifications (2015–2024) using trained RF model

Tree Persistence Analysis

- Sum of binary tree masks over 10 years (2015–2024)

Per-pixel canopy change Vector Analysis

- A linear fit reducer is applied across the collection, fitting a straight line at each pixel location. The derived slope shows the average rate of change in tree presence over time:
- Positive slope = increasing tree cover, Negative slope = decreasing tree cover, Near-zero slope = stable tree cover.

Fig 5, (above) Spatial change vector mapping showing THaW canopy expansion (Green) and contraction (Red) as a per-pixel value across the Knepp Estate rewilding area, West Sussex.

References

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2. Luscombe, D. J., Gatis, N., Anderson, K., Carless, D., & Brazier, R. E. (2023). Rapid, repeatable landscape-scale mapping of tree, hedgerow, and woodland habitats (THaW), using airborne LiDAR and spaceborne SAR data. Ecology and Evolution, 13, e10103. https://doi.org/10.1002/ece3.10103
3. (https://hedgerowsurvey.ptes.org/hedge-structures)

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