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**Leverhulme Centre**  
for Nature Recovery

# Multiple benefits of nature-based climate adaptation and mitigation actions

APSE Big Energy Summit, 26 February 2025

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## **Introduction**

- What are Nature-based Solutions?
- Multiple benefits of NbS for climate adaptation and mitigation

## **Nature-based Solution Opportunity Maps**

- Creating an inventory of natural climate assets
- Mapping and assessing evidence-based policy options

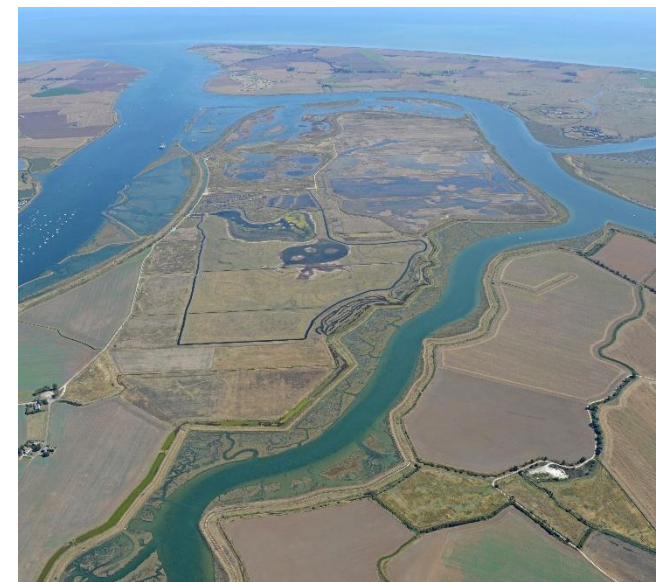
## **Pathways to Zero Carbon (Oxfordshire case study)**

- Scale and limits of nature-based climate mitigation
- Climate-nature synergies and trade-offs

# What are Nature-based Solutions (NbS)?

Nature-based solutions involve working with nature to address societal challenges, with benefits for **both people and biodiversity**

They include actions to protect, restore, sustainably manage and create new ecosystems in urban, rural, agricultural, freshwater, coastal and marine environments....



# Nature-based Solutions can protect, restore, enhance and manage...

## Woodlands, hedgerows, agroforestry



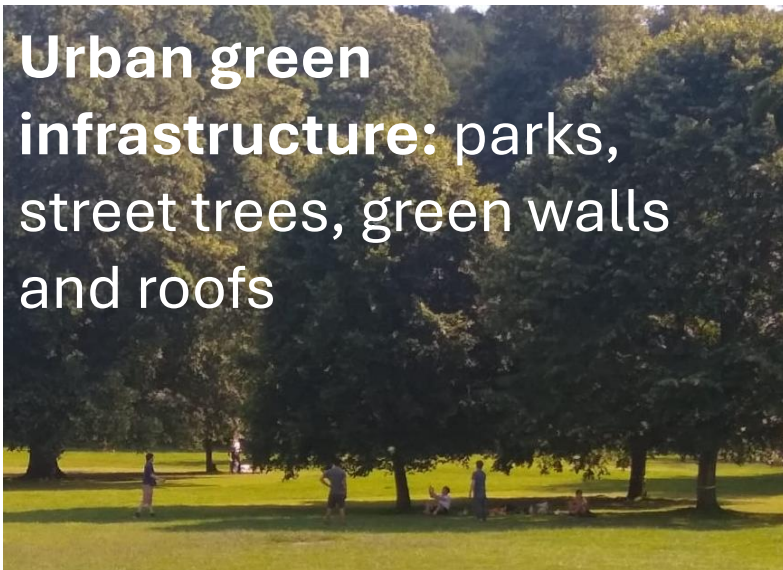
## Peatland



## Other habitats: grasslands, shrub, heath, wetlands



## Urban green infrastructure: parks, street trees, green walls and roofs



## Farmland soils, e.g. via cover crops, no-till, organic farming



## Saltmarsh, seagrass, kelp



# Not all nature-based interventions are NbS...

**Plantations of non-native species**  
(e.g. Sitka Spruce) are not usually NbS



**Biofuel crops** (e.g. Miscanthus grass) are not usually NbS



They may be needed for timber, fibre and fuel but they generally have little biodiversity value (unless being used to regenerate badly degraded land)

**Trees in the wrong place** (e.g. on species-rich grassland or peat) are also not NbS

# The four NbS guidelines

[www.nbsguidelines.info](http://www.nbsguidelines.info)

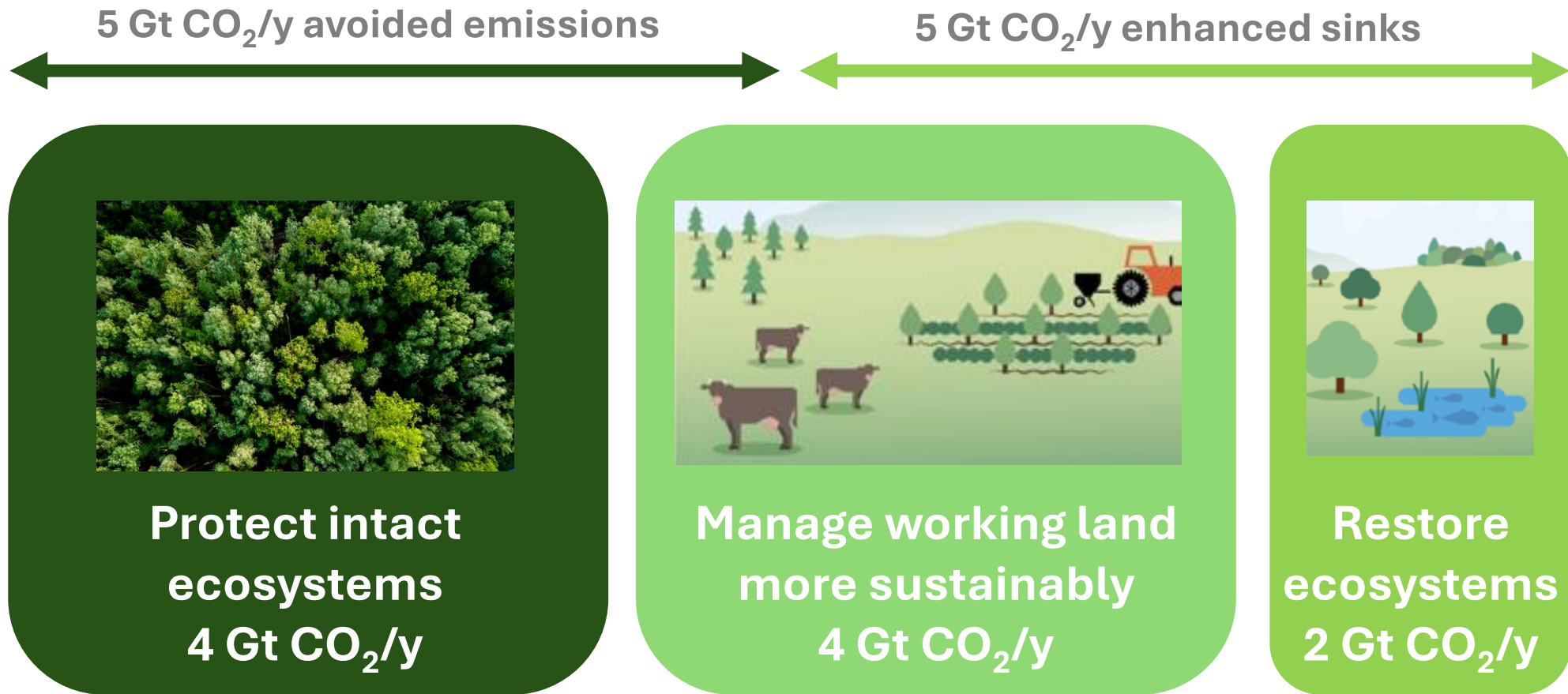
1. NbS are not a substitute for the rapid phase-out of fossil fuels
2. NbS involve a wide range of ecosystems on land and at sea
3. NbS are designed by or in partnership with local communities
4. NbS are explicitly designed to support or enhance biodiversity

See also the [IUCN Global Standard for Nature-based Solutions](#).



# Nature-based solutions for climate change mitigation

**Global carbon emissions 41 Gt CO<sub>2</sub>/y (fossil fuels and land use change)**  
Global estimated cost-effective potential reduction from NbS **10 Gt CO<sub>2</sub>/y**



Cost-effective climate mitigation from NbS on land (<\$100 / t CO<sub>2e</sub>)

Girardin et al 2021, Nature-based solutions can help cool the planet – if we act now. *Nature*.

# Nature-based solutions for climate change adaptation

Coastal flooding and erosion

## Coastal & marine

- Saltmarsh (managed realignment)
- Sand dunes
- Seagrass meadows
- Kelp forests
- Coldwater reefs
- Coral reefs
- Mangroves

Inland flooding and erosion

## Natural flood management (NFM)

- Rural woodlands
- Leaky dams / bunds
- Floodplain reconnection, river restoration
- Peatland and grassland restoration

## Green and blue infrastructure

- Sustainable drainage (SuDS), Green roofs / walls
- Urban trees and green spaces

## Agro-ecology

- Agro-forestry, hedgerows, buffer strips
- Cover crops, minimum tillage, soil organic matter, crop diversity etc

Water supply and quality

Heatwaves

Food security

Marine protected areas, seagrass, kelp, etc



# Nature-based solutions could address 33 of the 34 UK climate risks where further adaptation action is needed and **all 8** top priority risks

Priority climate risk (UK CCRA3)	How NbS can contribute
<b>1</b> Risks to the viability and diversity of <b>habitats and species</b>	NbS support or enhance biodiversity and ecosystem health, which underpins resilience
<b>2</b> Risks to <b>soil health</b> from flooding and droughts	Agro-ecological methods e.g. cover crops, hedgerows, agroforestry, improve soil structure, drainage, infiltration and water storage
<b>3</b> Risks to <b>carbon stored in ecosystems</b>	Ecosystem protection and restoration, especially peatlands
<b>4</b> Risks to <b>farming &amp; forestry</b> from heat stress, drought, flooding, fire, pests, diseases, invasive species	Agro-ecological methods e.g. cover crops, buffer strips, hedgerows and agroforestry, species-rich field margins, agroforestry and crop diversity
<b>5</b> Risk of <b>collapse of supply chains</b> for food, goods and vital services	Agro-ecological methods can improve food and water security globally. NFM can reduce flood and erosion risks to infrastructure.
<b>6</b> Risks to people and the economy from <b>power system failure</b>	NbS can protect power stations from flooding and coastal erosion, and protect cooling water supplies.
<b>7</b> Risks to human health and productivity from <b>overheating</b>	Green roofs and walls, green spaces and trees can cool buildings and reduce energy demand for air conditioning
<b>8</b> Risks to the UK from climate change <b>impacts overseas</b>	NbS can help all nations adapt to climate risks, reducing geopolitical and supply chain risks to the UK

# Co-benefits

Air  
quality

Carbon storage/  
sequestration

**Biodiversity**

Health and  
wellbeing

Livelihoods

**Coastal and marine NbS**

Rural woodlands

Floodplain reconnection

Peatland and grassland restoration

**Natural flood management**

River restoration, beaver dams

Some trade-offs

Green roofs / walls

Urban trees and green spaces

**Green and blue infrastructure**

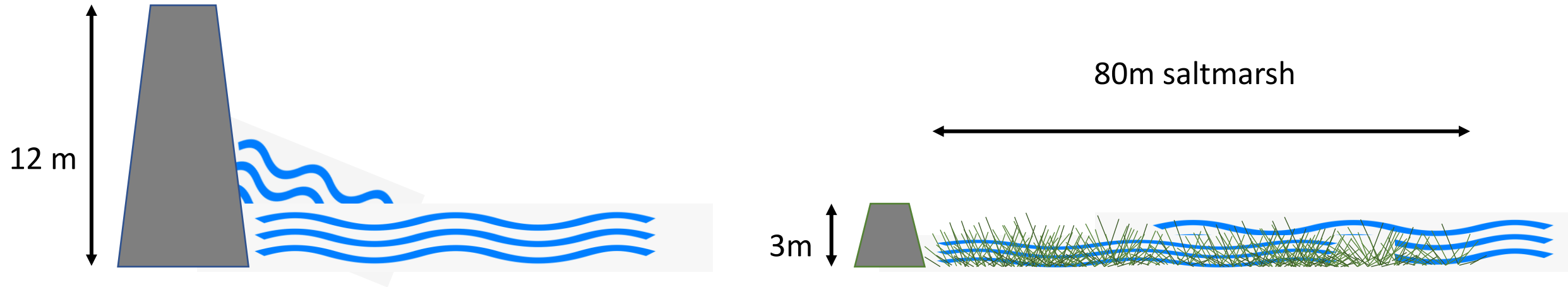
Sustainable drainage (SuDS)

Agro-forestry, hedgerows, buffer strips

Cover crops, minimum tillage, soil organic matter, crop diversity etc

**Agro-ecology**

## Hybrid NbS and grey infrastructure: saltmarsh protecting sea wall



80m strip of saltmarsh means only a 3m wall is needed

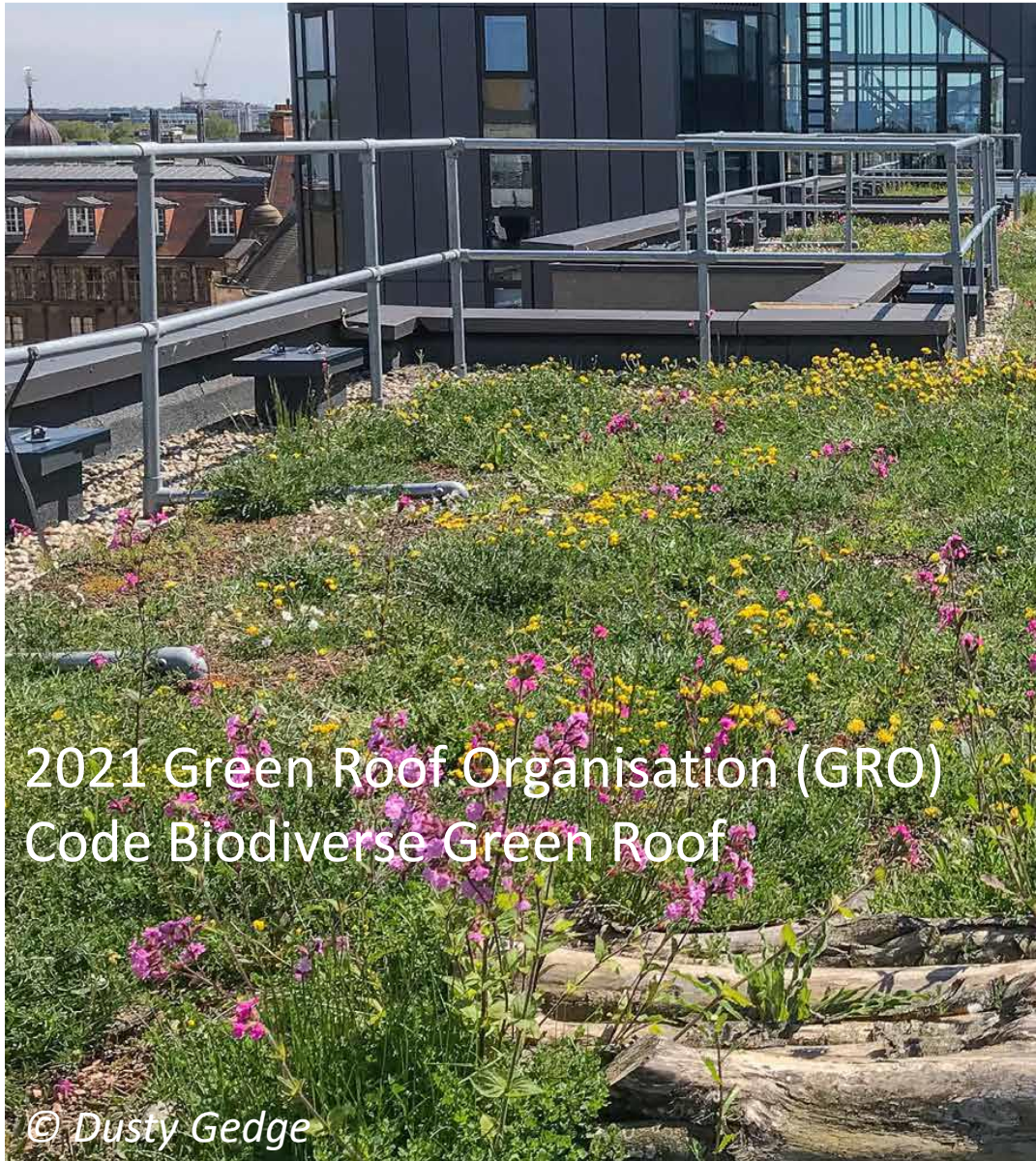
New wall: saltmarsh saves £2600 to £4600 per metre constructed

= £300,000 to £600,000 per hectare of saltmarsh

= 100 times the price of Grade 1 agricultural land

Existing wall: saves £6,000 per ha of saltmarsh in sea wall maintenance costs

# Standards: Biodiverse green roofs vs thin sedum mats

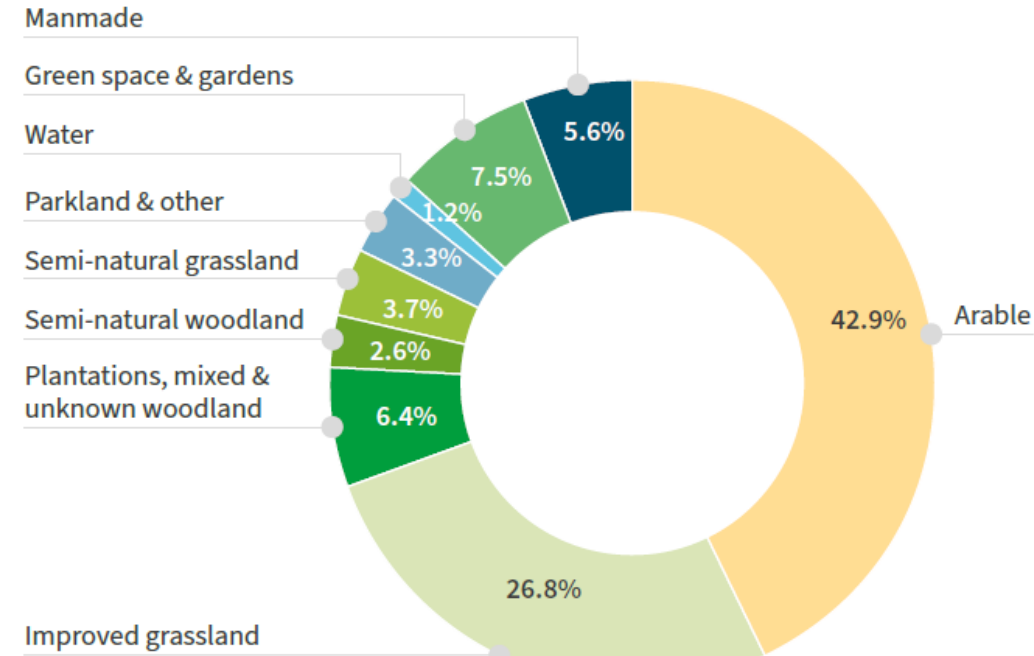
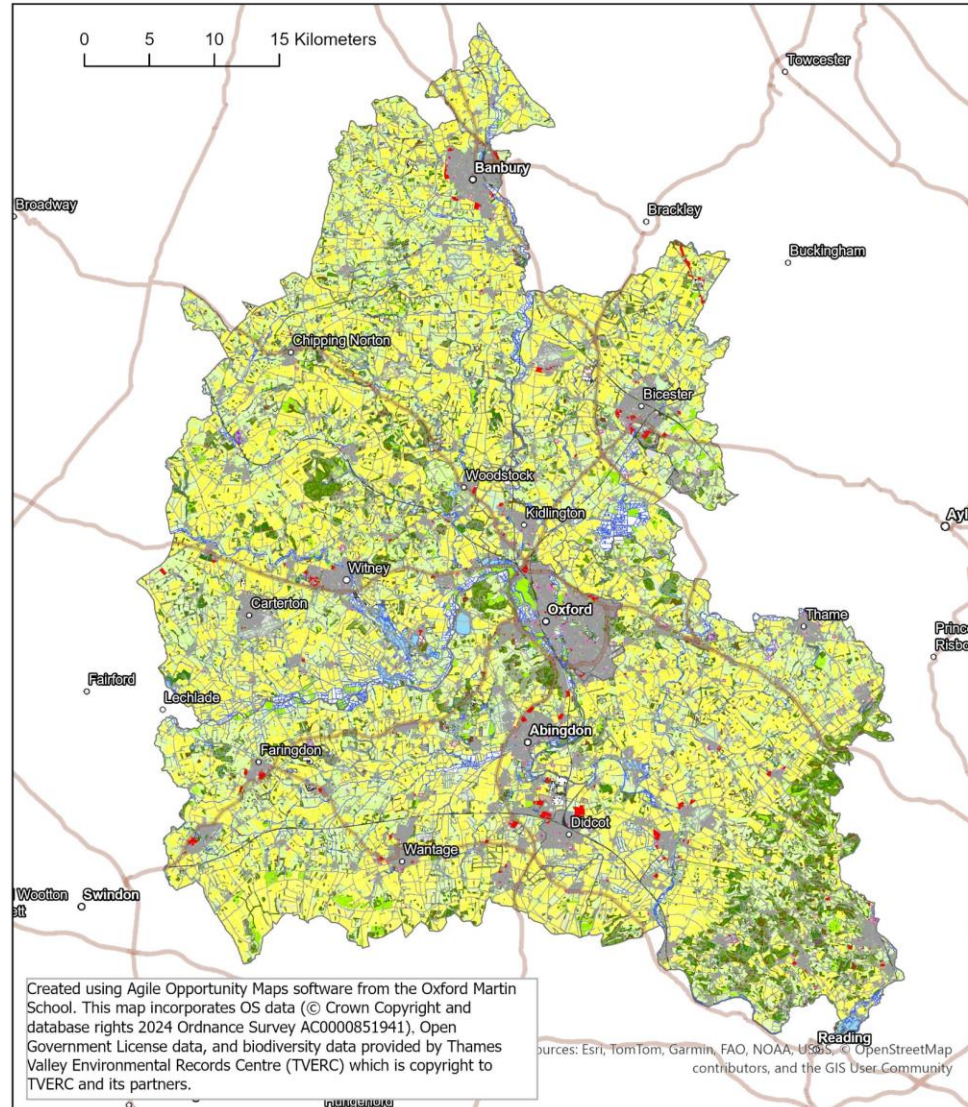


# Standards are vital, e.g. multifunctional SuDS

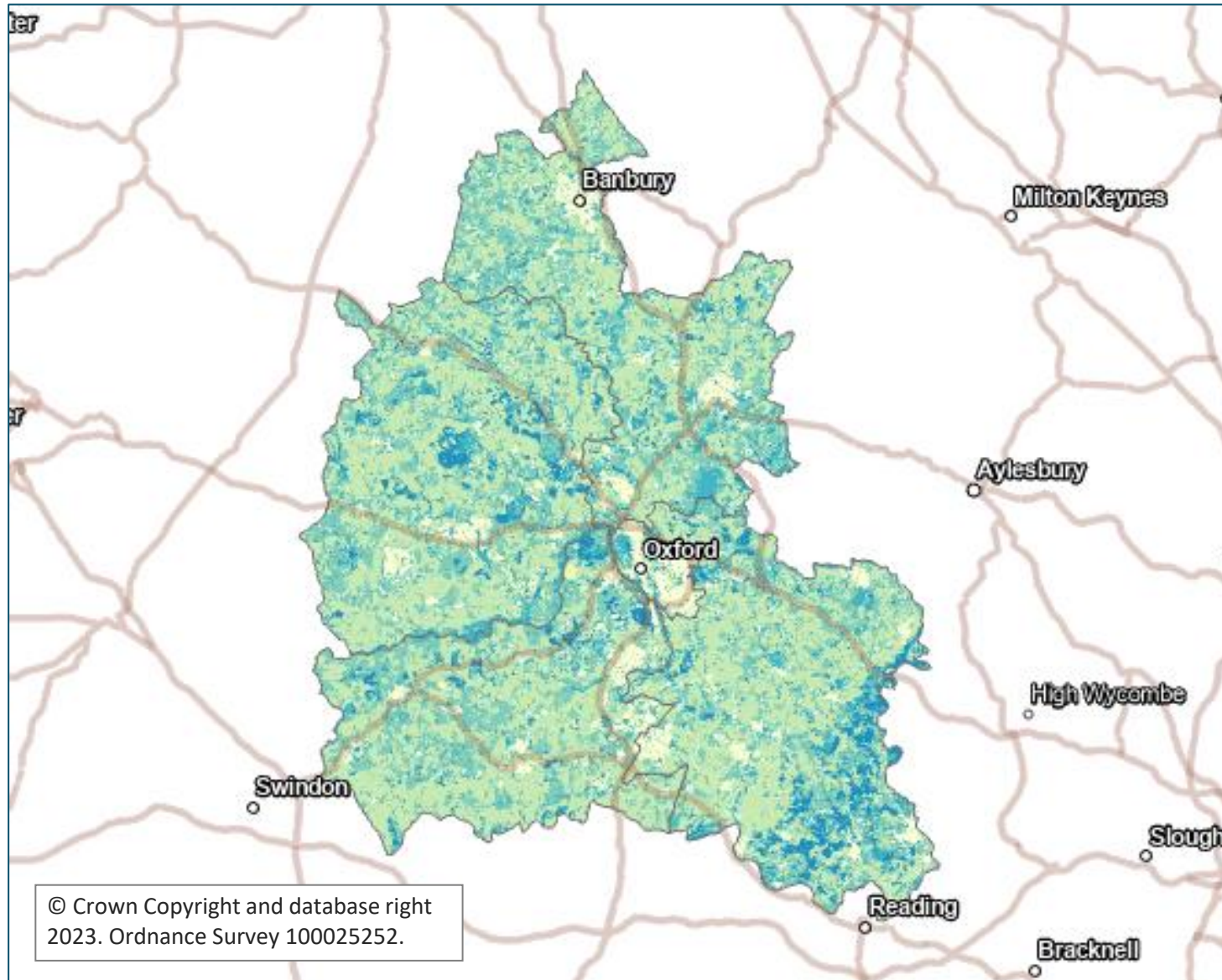


# Asset inventory: Agile Habitat map of Oxfordshire

- Arable
- Improved grassland
- Semi-natural grassland
- Broadleaved woodland
- Coniferous woodland
- Wood pasture and parkland
- Orchards
- Scrub
- Heath
- Bog
- Fen, marsh and swamp
- Water
- Coastal
- Rock, scree and boulders
- Urban green space
- Built-up areas
- Quarry, landfill, bare ground
- New development



# Carbon storage t/ha. Total 23 Mt C in soil and vegetation.



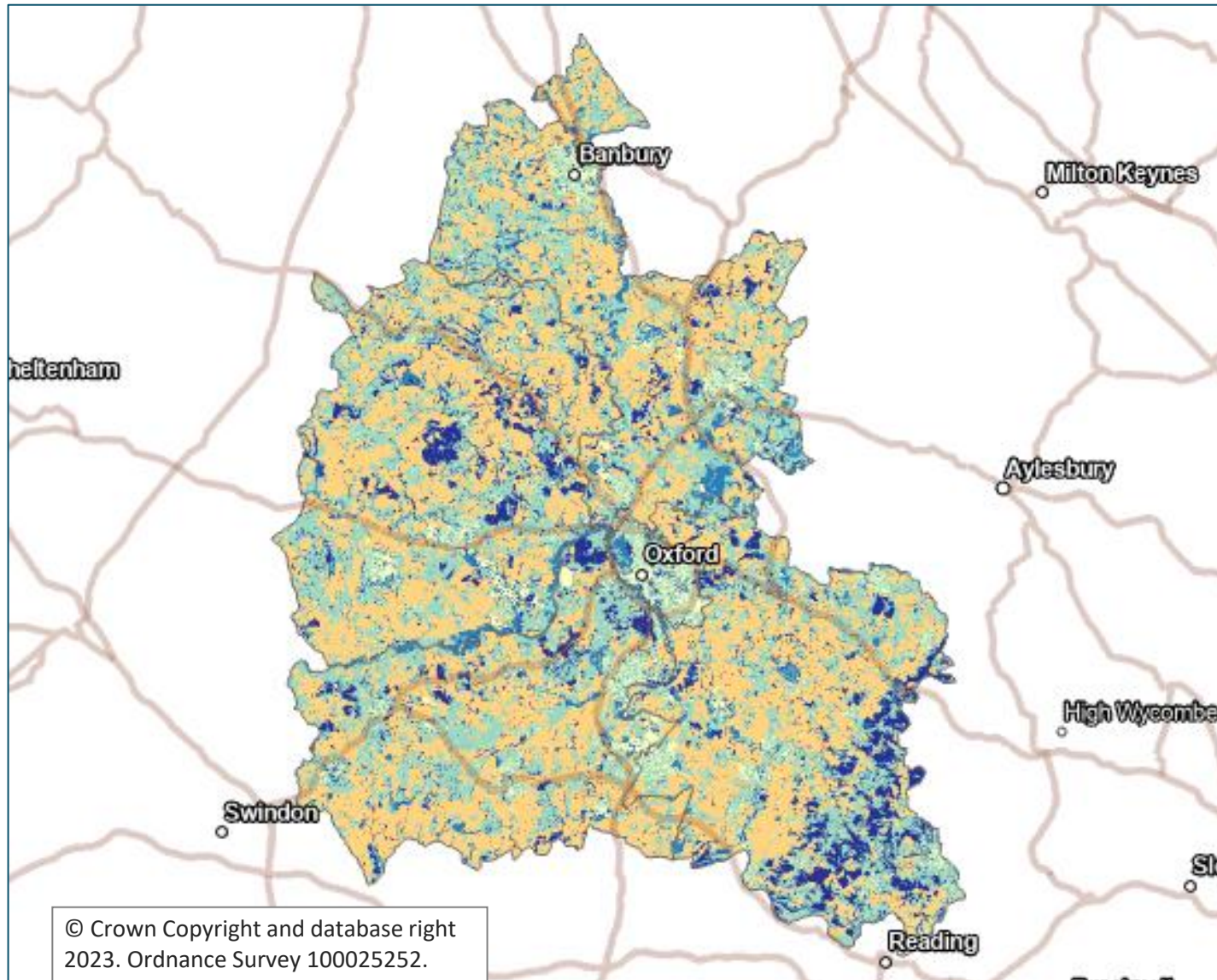
**Non-peat soils:** estimates per habitat from various literature sources e.g. Cantarello et al 2011; Natural England (Gregg et al 2021)

**Peat soils:** Natural England peat status and GHG emission dataset

## Carbon\_tha



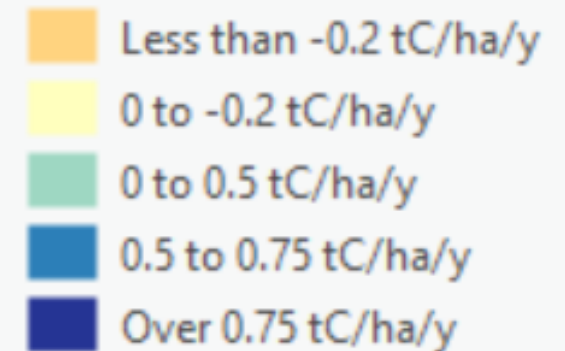
# Carbon sequestration t/ha/y. Total 115,000 tC/y



**Non-peat soils:** estimates per habitat from various literature sources e.g. Cantarello et al 2011; Natural England (Gregg et al 2021)

**Peat soils:** Natural England peat status and GHG emission dataset; Evans et al.

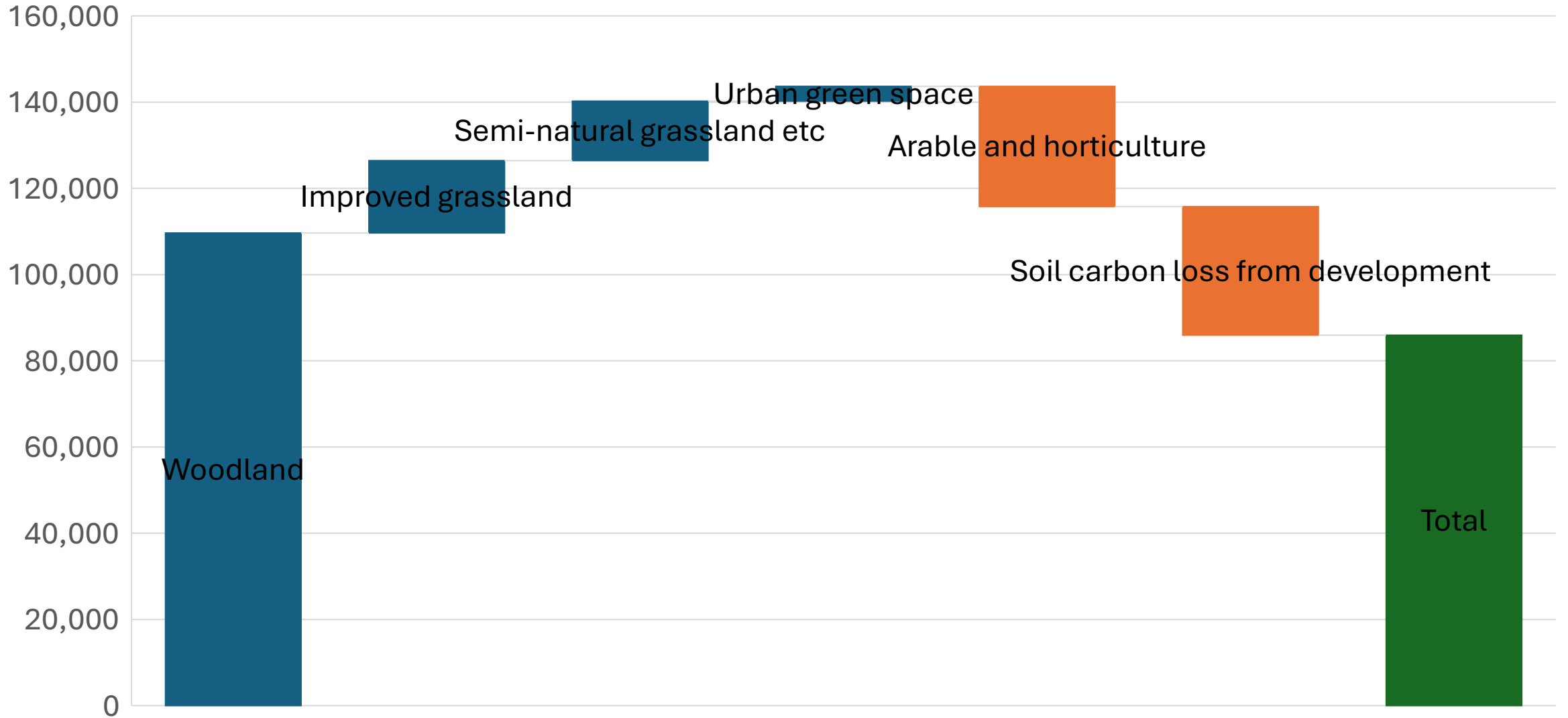
Cseq\_tC\_ha\_y



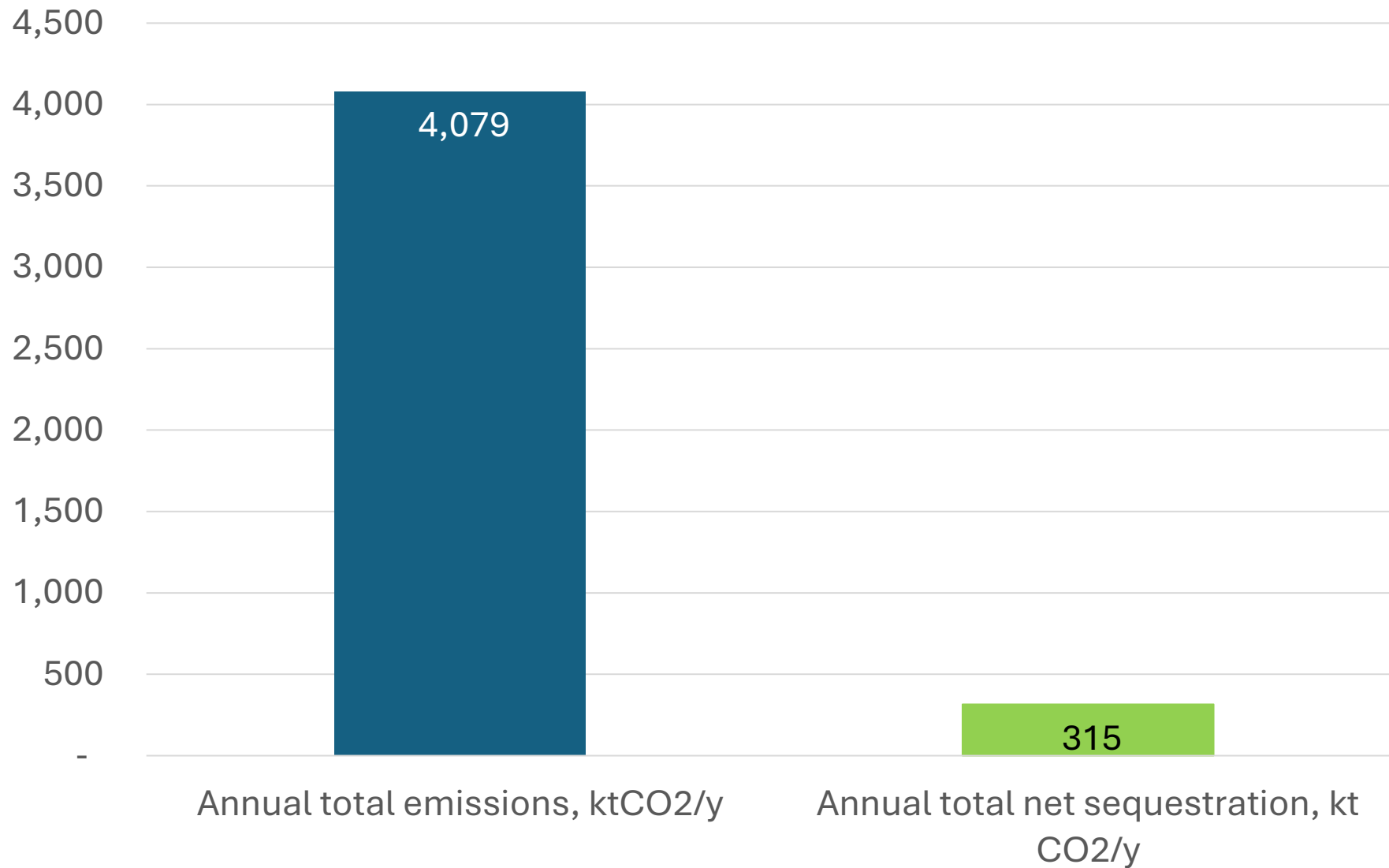


# Carbon sequestered by habitat, t C/y

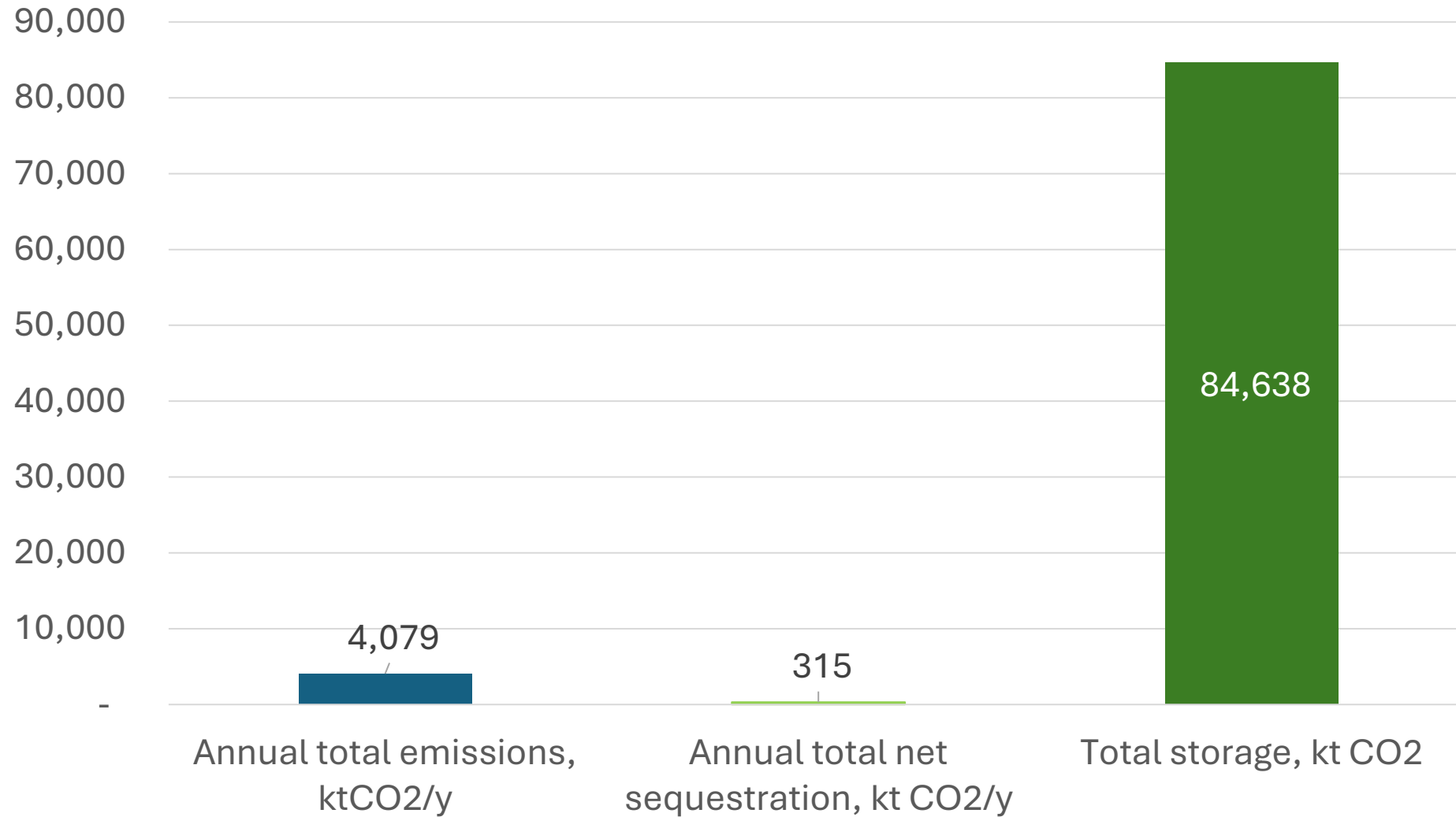
■ Increase ■ Decrease ■ Total



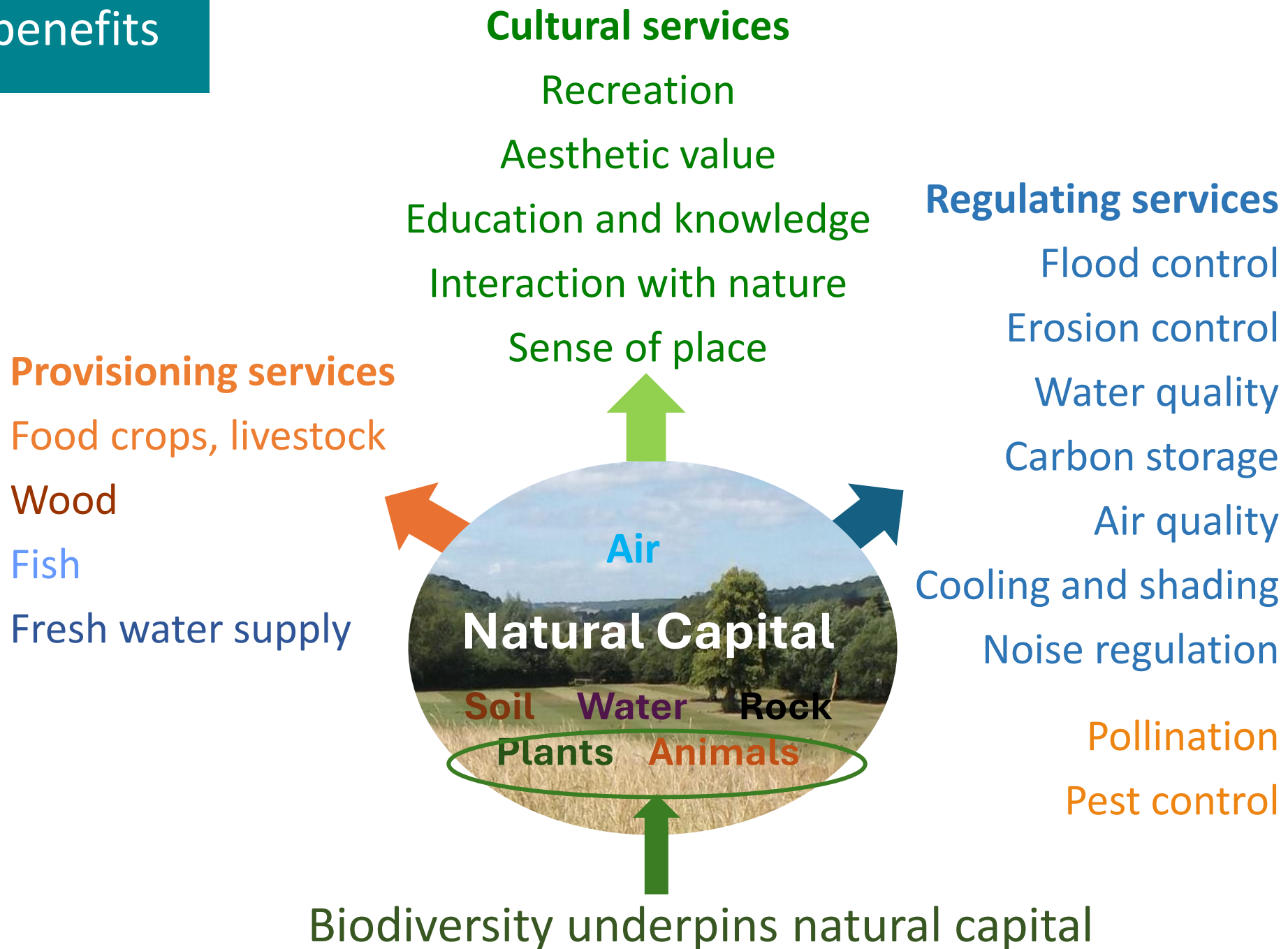
# Net sequestration is only 8% of emissions from fossil fuels...



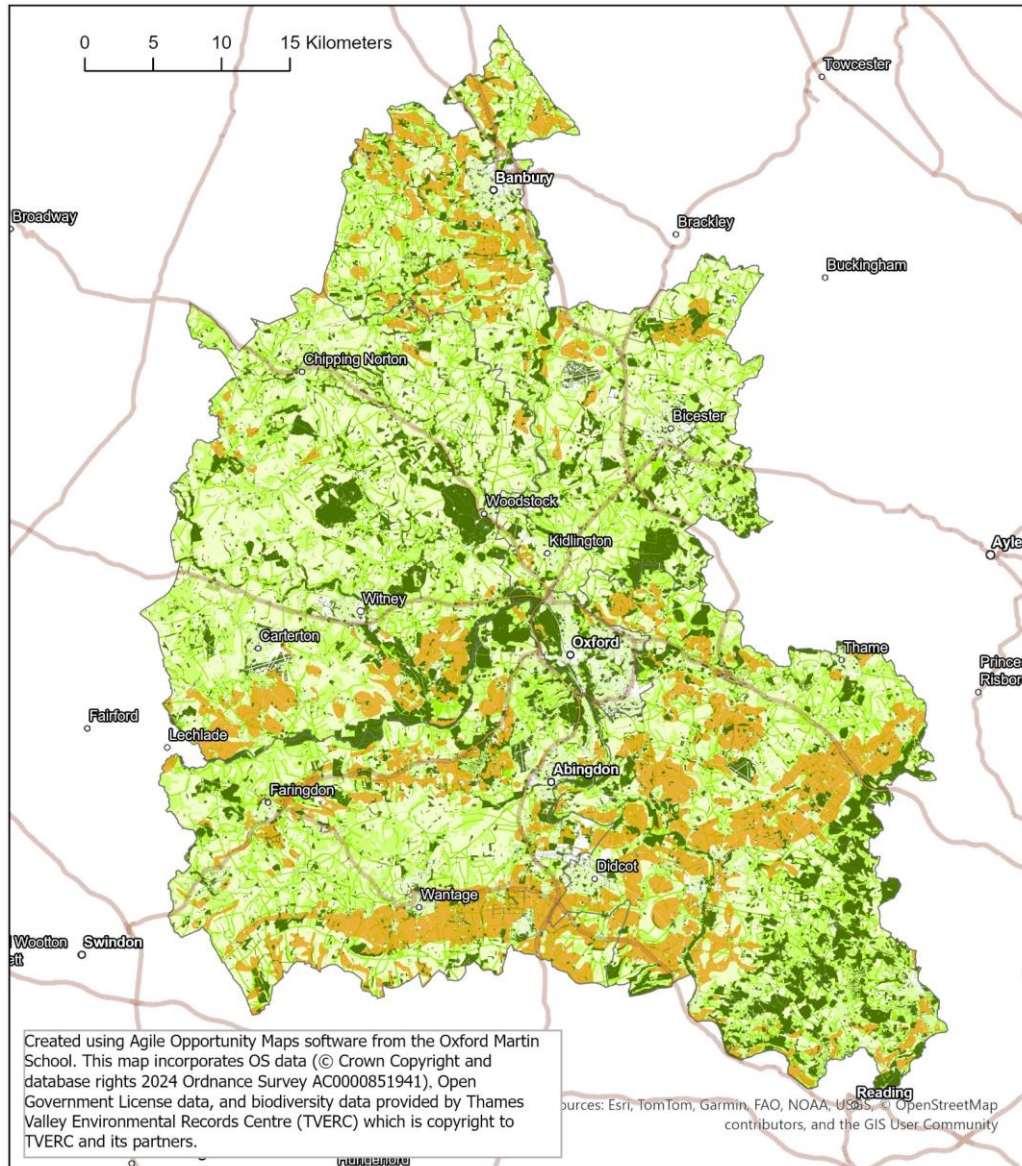
# But carbon stored in ecosystems is far greater than emissions



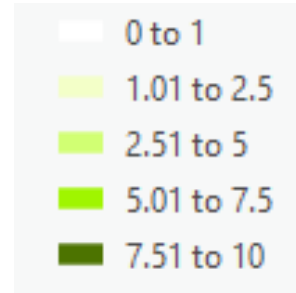
# Multiple benefits



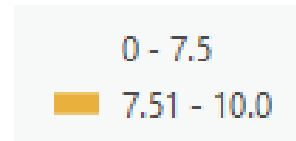
# High value assets for ecosystem services



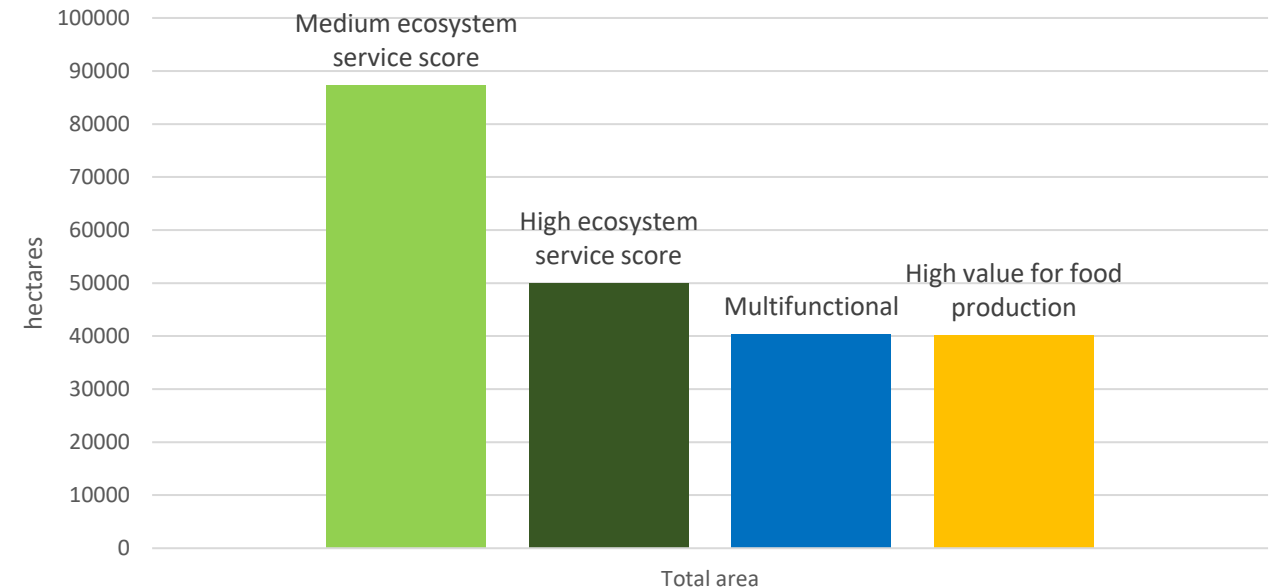
Maximum regulating and cultural service score



Food production score



High value natural assets



# Mapping evidence-based opportunities for nature-based solutions

## Constraints:

High grade farmland

Semi-natural habitats

Peaty soils

Designated areas – may be constraints

## Opportunities:

Potential habitat networks:

- Woodland
- Grassland – Acid, Neutral, Calcareous
- Heathland
- Wetlands (flood zone; wetness index)

Peatland restoration

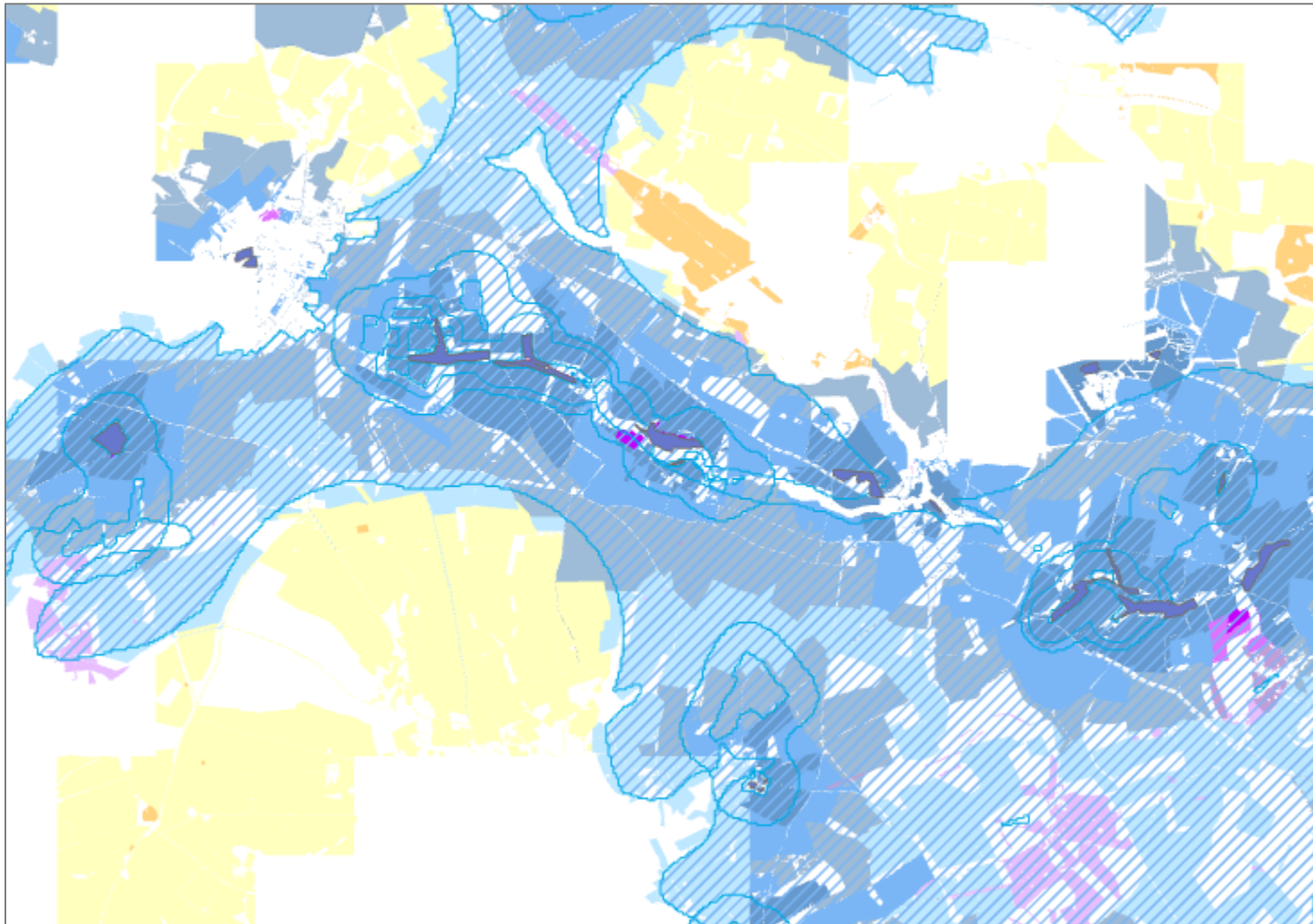
Agroforestry

Community orchards (near urban areas)

Erosion prevention (steep slopes and erodible)

Natural flood management (upper catchments, poorly drained soils)

# Habitat network approach



Core calcareous grassland  
Calcareous grassland network

- 200m
- 500m
- 1000m
- Extension zone
- No constraints

## Opportunities in designated areas

- 200m, designated
- 500m designated
- 1000m designated
- Extension zone, designated
- No constraints, designated

Natural England lowland calcareous grassland habitat network

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# Example output: high priority opportunities in each location

## Options for field A:

Grass,  
Orchard,  
Silvopasture,  
Silvoarable

## Options for field B:

Wetland  
mosaic

## Options for field C:

Natural  
regeneration,  
Silvopasture



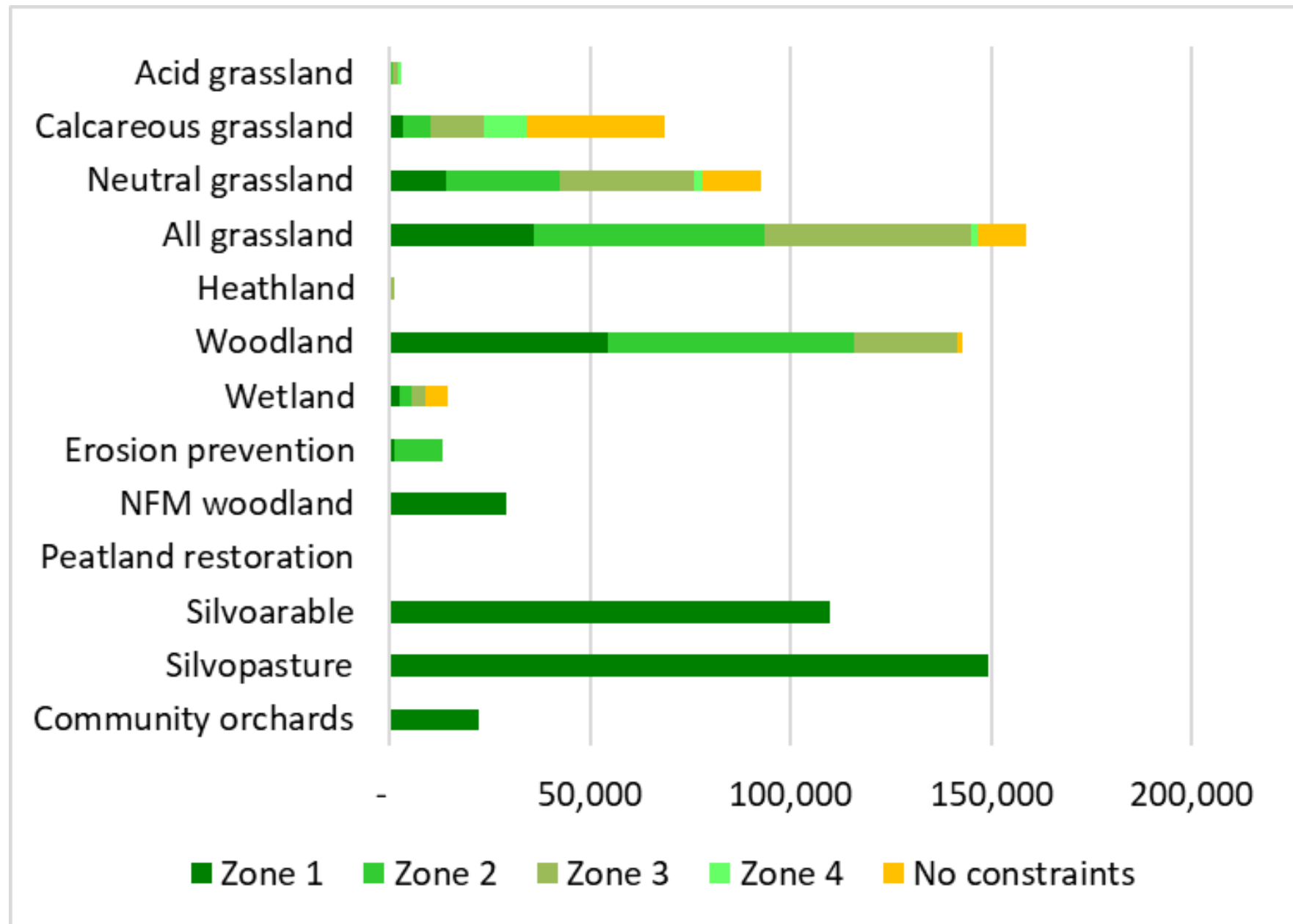
## Main potential opportunities

- Natural regeneration
- Wood
- Grass
- Grass, Wood
- Heath
- Grass, Heath
- Heath, Wood
- Peat
- Wetland
- Wetland, Grass
- Orchard
- Grass, Orchard
- Silvopasture
- Silvoarable

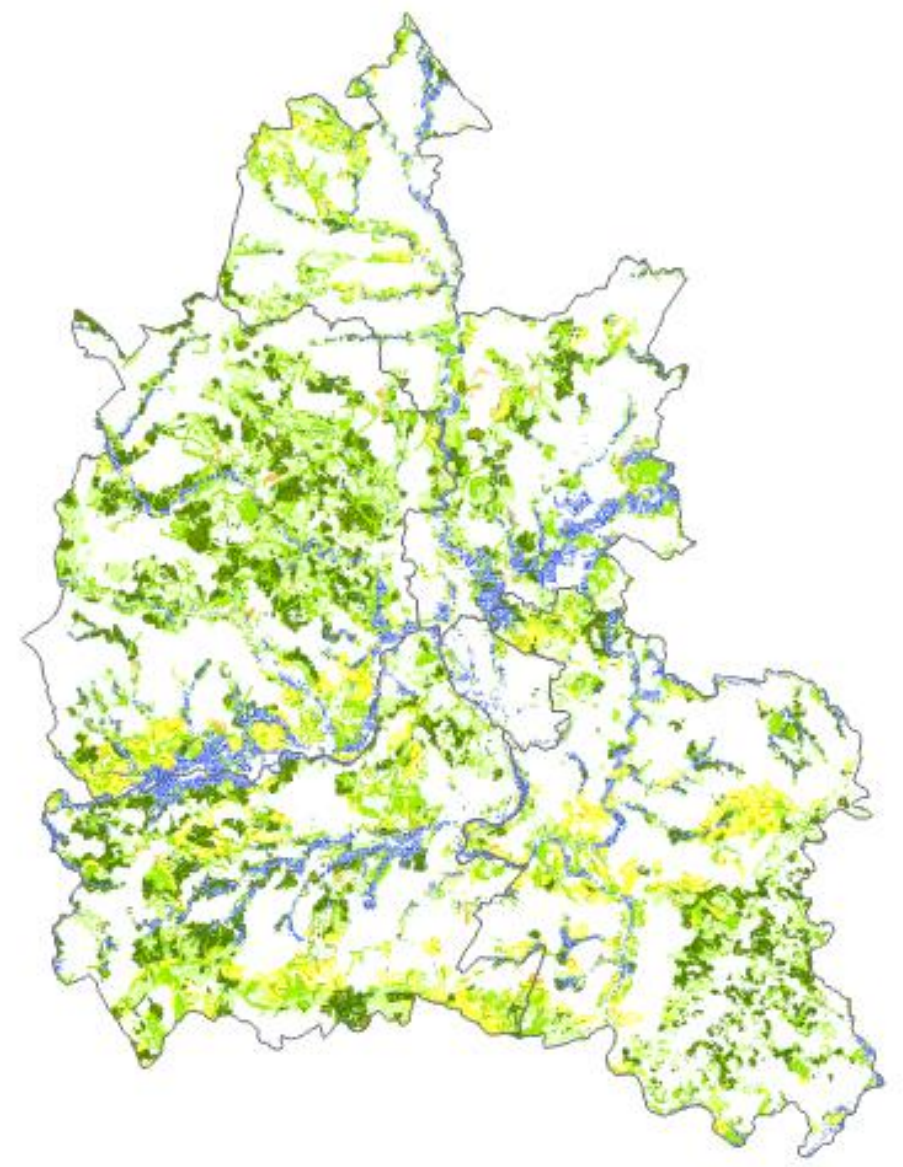
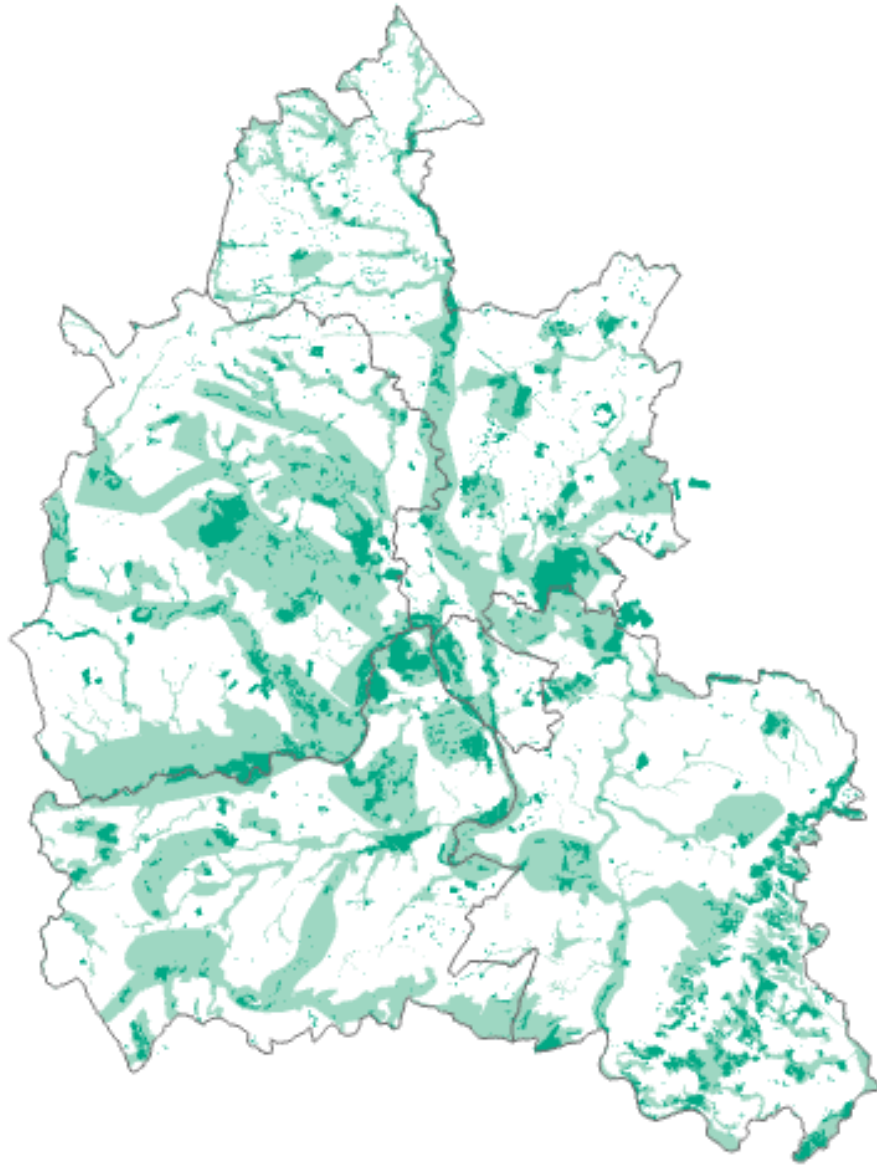
Use as part of a participatory stakeholder engagement process with ground truthing and input from local experts



# Opportunity assessment



# Using with Local Nature Recovery Strategies: a focused network



## Study for Oxfordshire County Council

### Four scenarios:

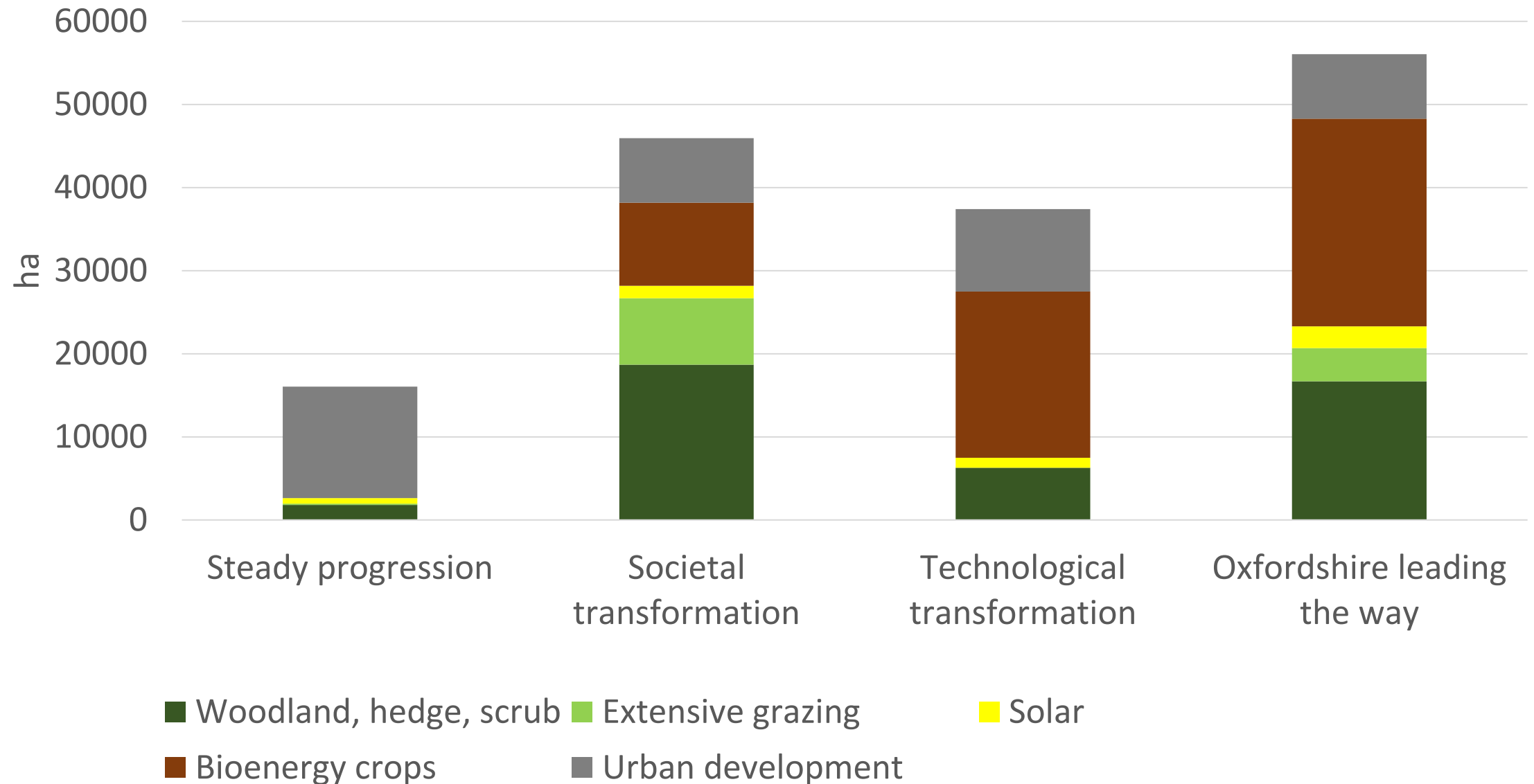
- Steady progression
- Societal transformation
- Technological transformation
- Oxfordshire leading the way

# Pathways to a zero carbon Oxfordshire

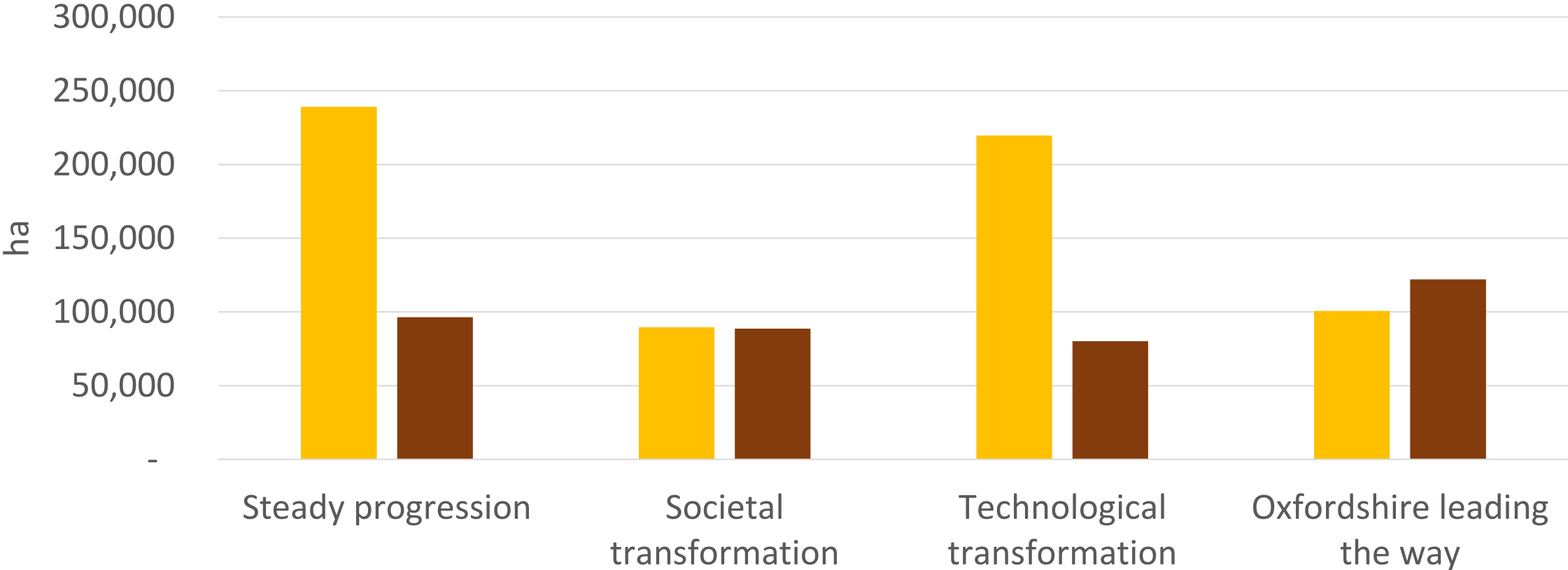
2021

	Land use options	Steady progression	Societal transformation	Technological transformation	Oxfordshire leading the way
Making space	Low meat diet	✘	✓	✘	✓
	Compact urban development	✘	✓	✘	✓
	Crop productivity increase	10%	20%	<b>39%</b>	20%
Cutting carbon	Trees planted, ha	1815	<b>13022</b>	6282	<b>13022</b>
	Other habitats restored , ha	150	<b>12000</b>	-	6000
	Bioenergy crops, total ha	-	10,000	20,000	<b>25,000</b>
	Solar farms, total ha	670	1,500	1,200	<b>2,600</b>
Low space carbon reduction	Agroforestry & hedgerows, ha	-	<b>41,885</b>	-	<b>41,885</b>
	Rooftop solar, total ha	167	496	131	<b>1,108</b>
	Green roofs, total ha	-	<b>793</b>	-	<b>793</b>
	Regenerative farming (% farmland)	-	80%	-	80%
<b>Net carbon sequestered 2020 to 2050 (Mt)</b>		<b>2.6</b>	<b>6.3</b>	<b>3.7</b>	<b>6.0</b>
<b>% of food demand met in Oxfordshire</b>		<b>40%</b>	<b>60%</b>	<b>39%</b>	<b>55%</b>
<b>% of bioenergy demand met in Oxfordshire</b>		<b>0</b>	<b>10%</b>	<b>20%</b>	<b>17%</b>

## Conversion of intensive farmland to other uses in each scenario



# Area needed for food and bioenergy crops outside Oxfordshire



- Hectares of land outside Oxfordshire needed for food (assuming same productivity)
- Hectares of land outside Oxfordshire needed for bioenergy feedstock crops

# Balancing land use trade-offs: making space for nature and carbon sequestration

- **Shift to a more plant-based diet.** Half of UK cereal crops are for animal feed.
- **Reduce food waste, increase agricultural productivity** (but sustainably)
- **Energy demand reduction** reduces need for biofuels and tree-planting
- **Land-sharing:** agroforestry, hedgerows, ag-electric (solar on farmland)
- **Compact urban development** incorporating green infrastructure, rooftop solar
- **Avoid converting high grade farmland** (grades 1, 2 or 3a) to other uses
- **Avoid planting trees or biofuels on semi-natural grassland or peat**
- **Avoid over-extraction from woodlands**



Structurally complex woodland

Ample nesting and hibernation sites for birds, small mammals and invertebrates





‘Bringing all woodlands into active management’?  
No cover and few resources for small mammals, birds and invertebrates

# Visit the NbS Knowledge Hub to find out more

<https://nbshub.naturebasedsolutionsinitiative.org/>



## Nature-based Solutions Knowledge Hub Home



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# Welcome to the nature-based solutions knowledge hub

An integrated one-stop resource to guide users through the process of governance, designing and funding Nature-based Solutions (NbS), and

## Featured updates

**River of Life: wetland restoration along the River Thames**

Feb 2024

Case study

**Hogacre Common Community Eco Park**

Feb 2024

Case study

**The Great North Bog: a partnership for landscape-scale peatland**

## Take-home messages

- NbS have multiple benefits for climate, health and economy
- Strong protection needed for existing carbon-rich ecosystems
- Limits to how much more carbon can be sequestered
- Make space for nature and carbon e.g. dietary change, rooftop solar, compact development
- Restore a balanced mix of habitats (grassland, wetland, peatland, woodland, shrubland) in line with Local Nature Recovery Strategies
- Co-design NbS with stakeholders' local knowledge, views and values

Thank you!

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