

Nature for resilience and security: evidence for smarter policymaking

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University of Oxford

National Biodiversity Network Conference
Leeds, 19 October 2026
***Nature as National Resilience**: turning biodiversity data into action for people, place and a changing climate*

The work of the Leverhulme Centre for Nature Recovery is made possible thanks to the generous support of the Leverhulme Trust

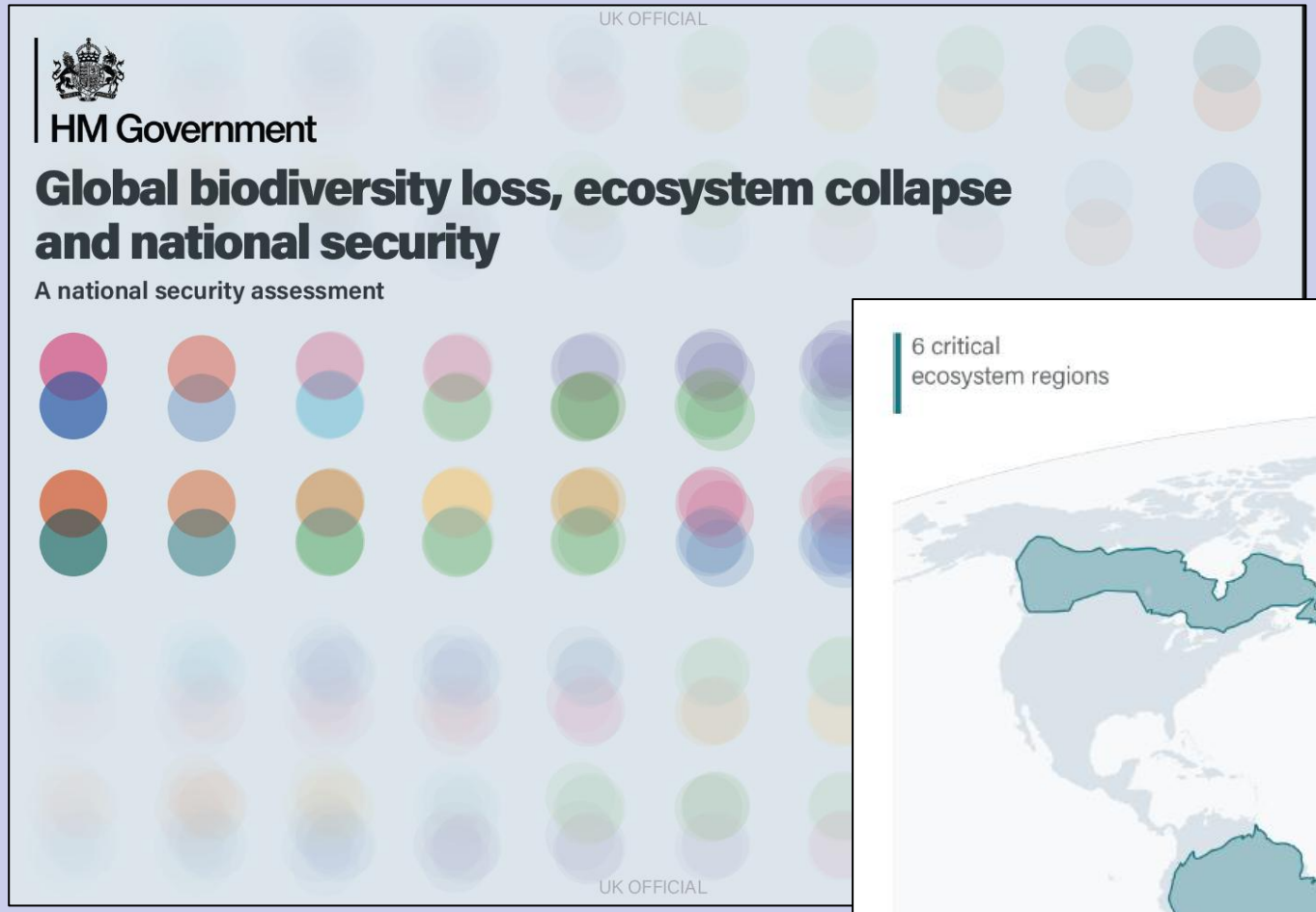


Nature for resilience & security: evidence for smarter policymaking

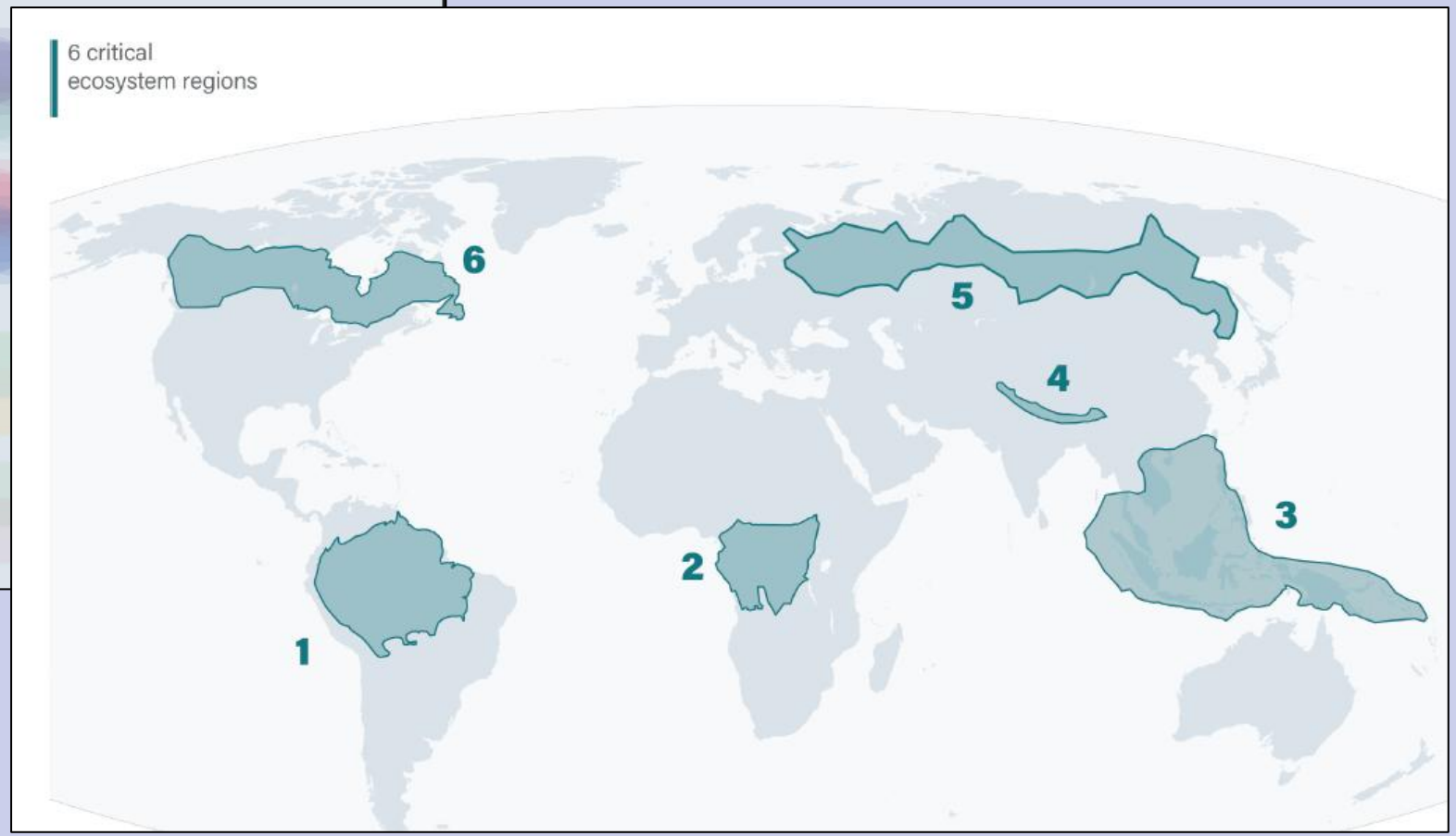
1. **Nature for resilience & security**: evidence synthesis
2. **Using data for smarter decisions**: LNRSs and the Agile opportunity maps
3. **Looking ahead**: where do we need more data and smarter policymaking?

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1. Nature for resilience and security: the evidence base



"Global ecosystem degradation and collapse threaten UK national security and prosperity."



https://www.gov.uk/government/publications/nature-security-assessment-on-global-biodiversity-loss-ecosystem-collapse-and-national-security

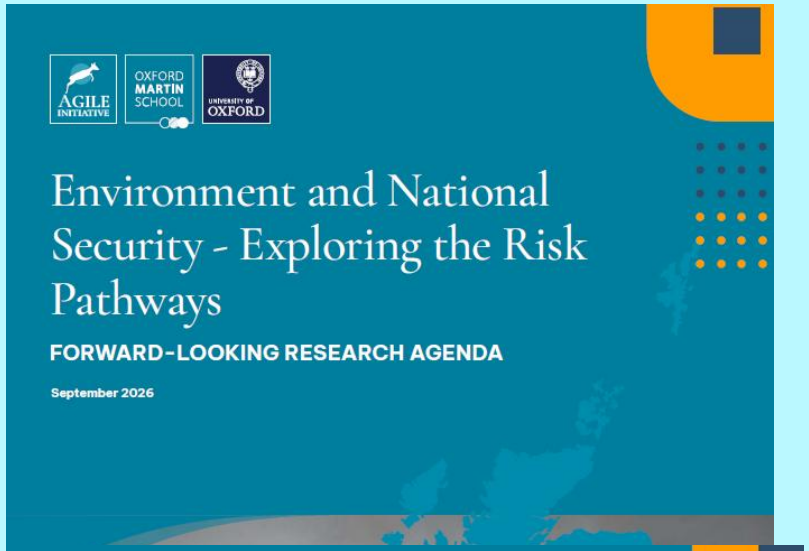
The Agile Initiative Research Sprint on:

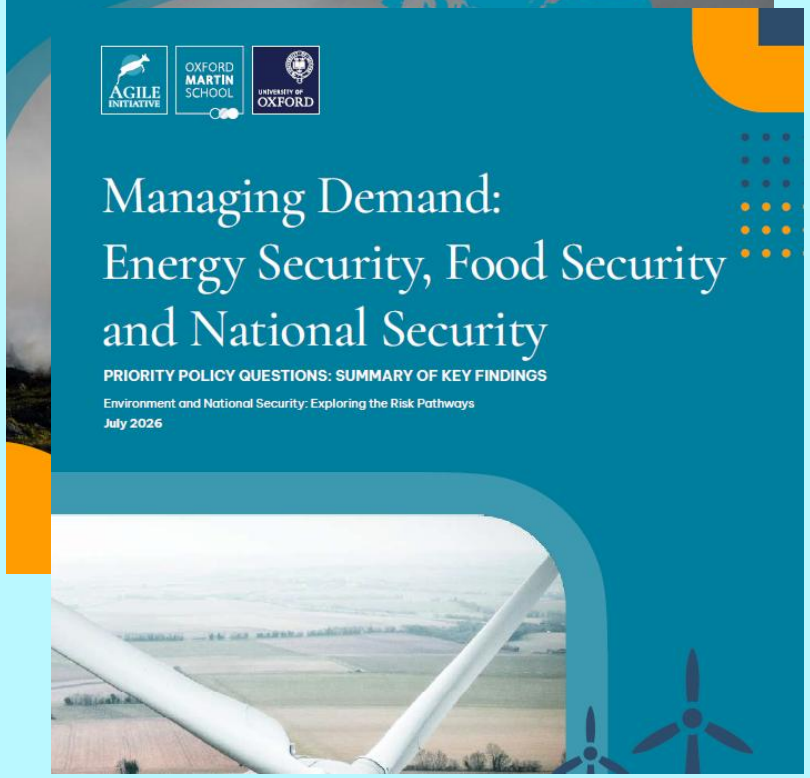
Environment & National Security

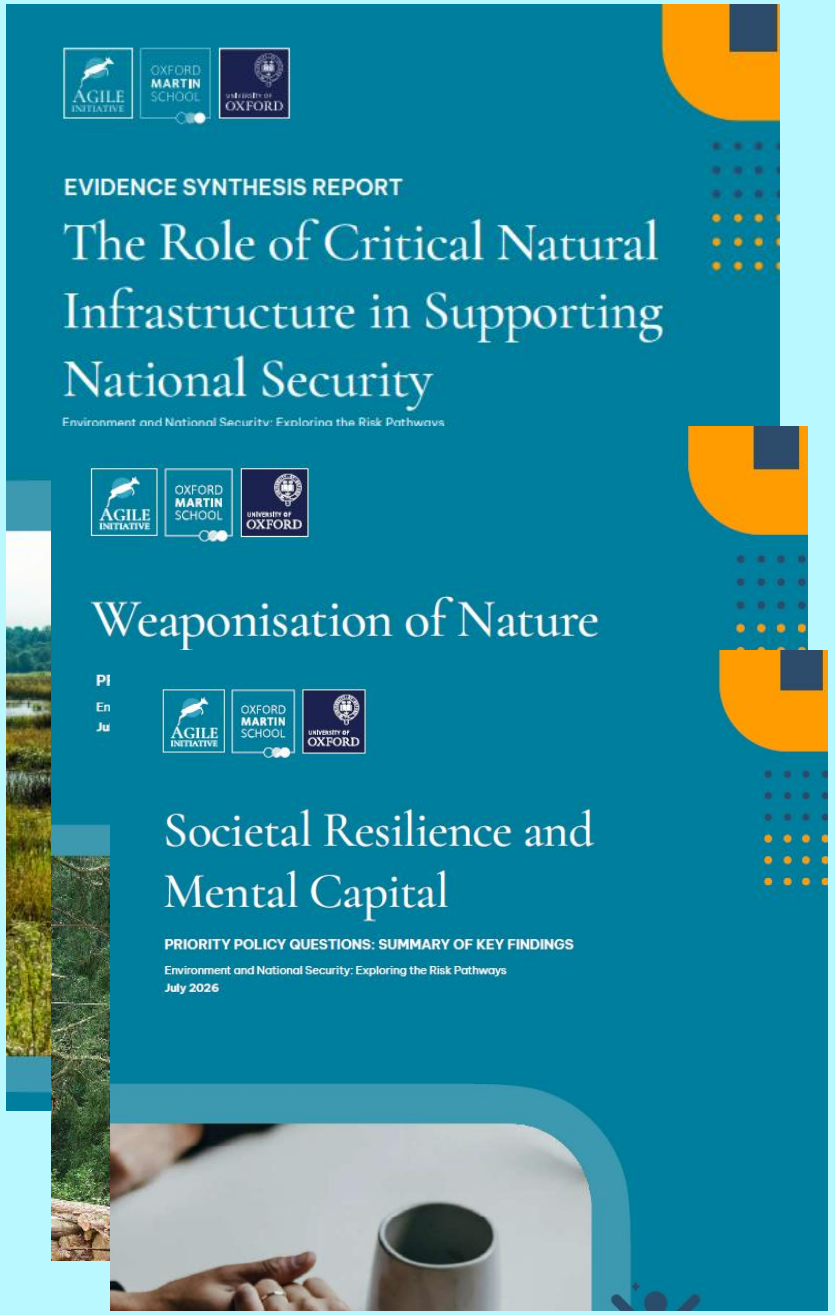
9 months Jan-Sept 2026
Co-created with government partners. Global and UK.

Evidence synthesis reports on

- Critical Natural Infrastructure
- Managing food & energy demand
- Weaponisation of nature
- Societal resilience

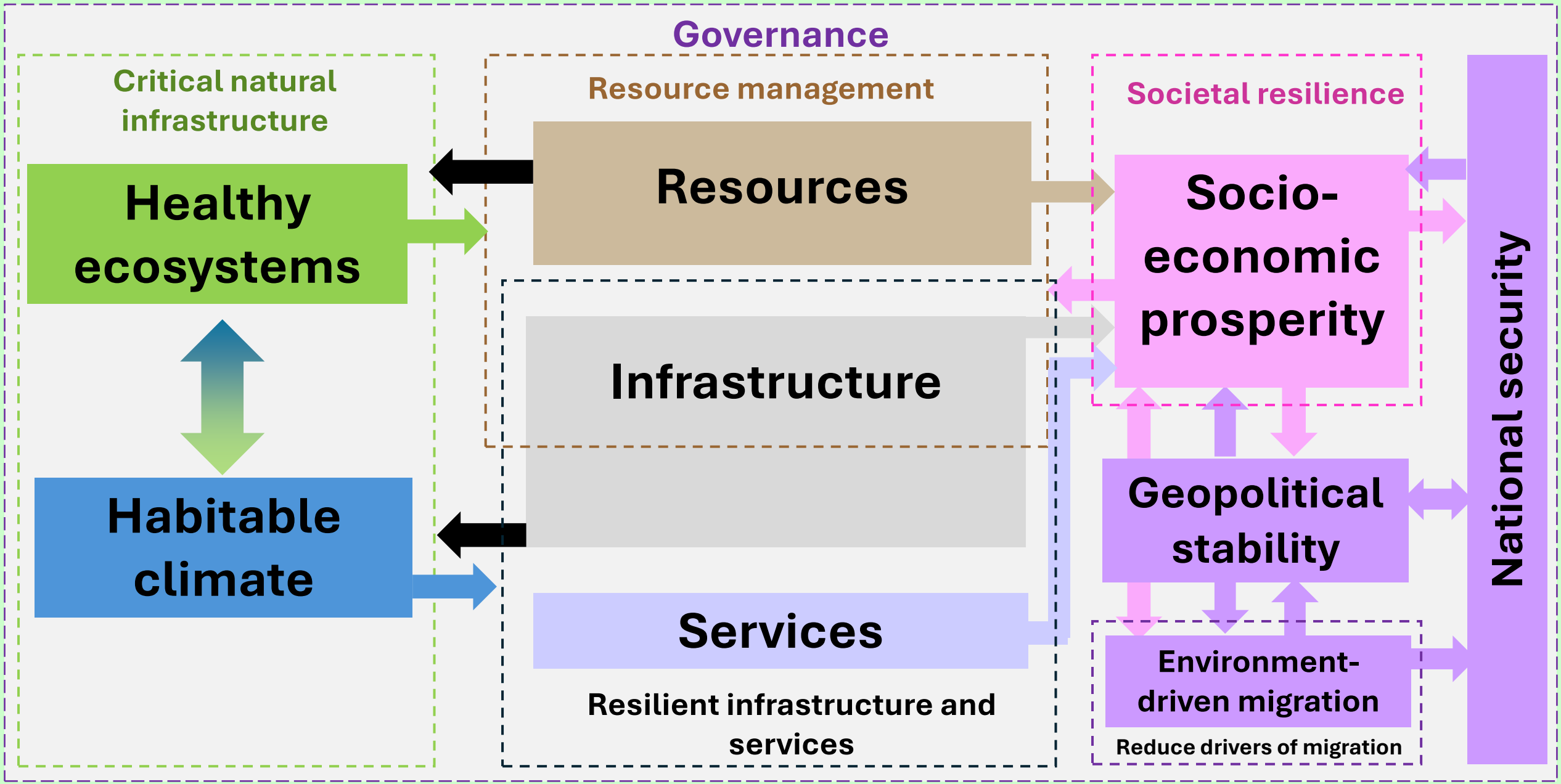


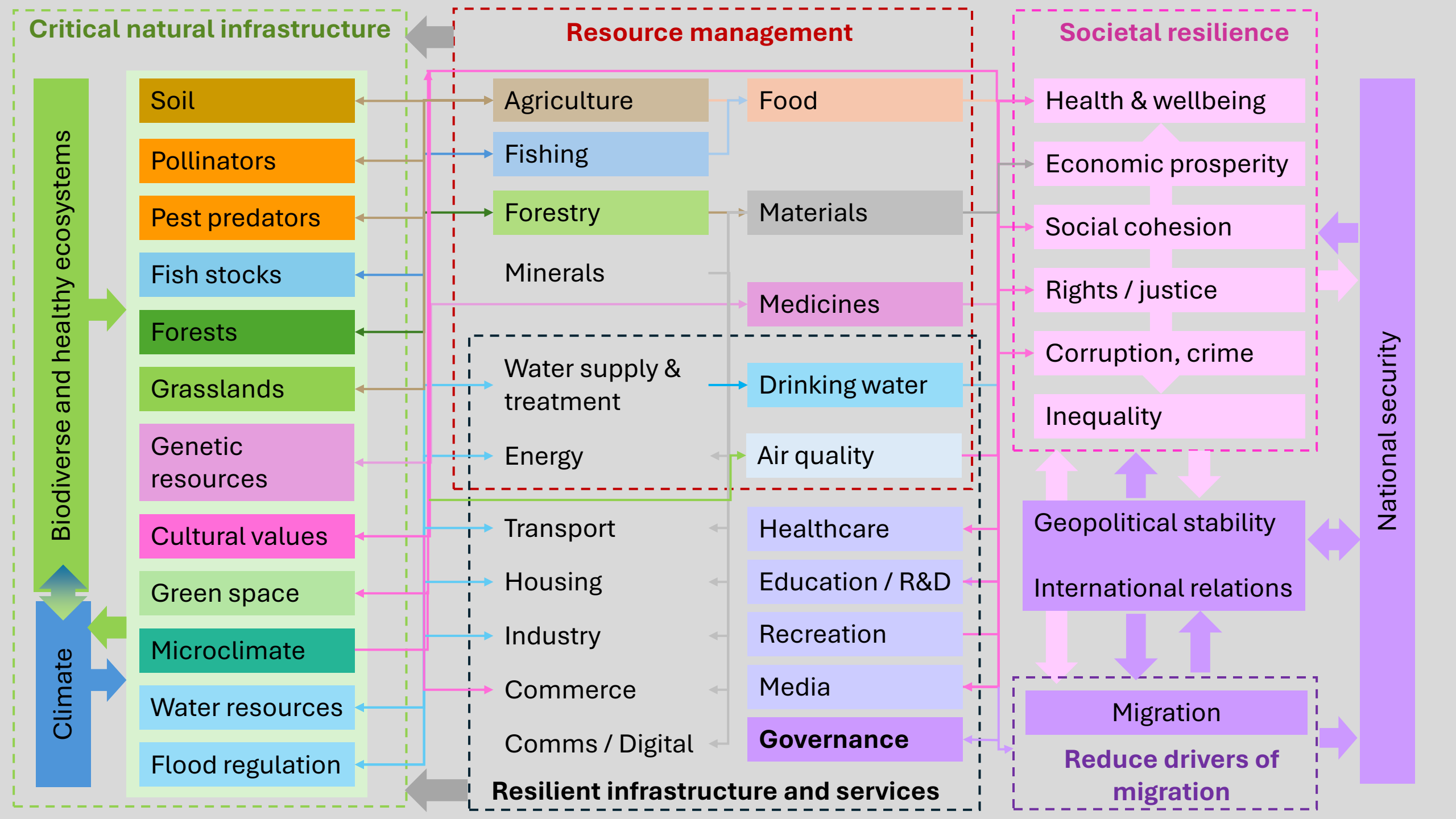




https://www.agile-initiative.ox.ac.uk/sprints/environment-and-national-security/

Nature for resilience and security

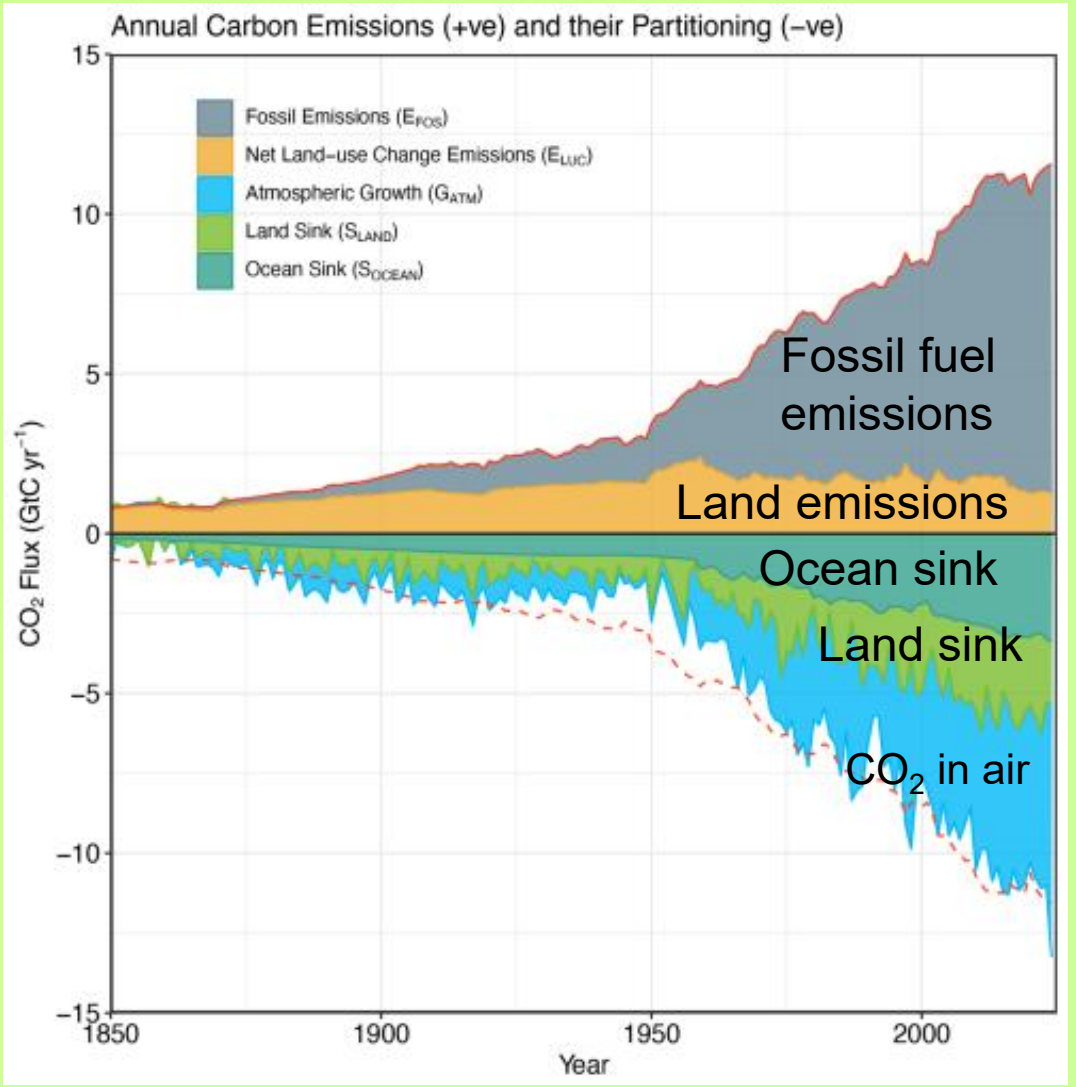



Critical natural infrastructure
Resource management
Societal resilience
Biodiverse and healthy ecosystems
Climate
Soil
Pollinators
Pest predators
Fish stocks
Forests
Grasslands
Genetic resources
Cultural values
Green space
Microclimate
Water resources
Flood regulation
Agriculture
Fishing
Forestry
Minerals
Water supply & treatment
Energy
Transport
Housing
Industry
Commerce
Comms / Digital
Food
Materials
Medicines
Drinking water
Air quality
Healthcare
Education / R&D
Recreation
Media
Governance
Resilient infrastructure and services
Health & wellbeing
Economic prosperity
Social cohesion
Rights / justice
Corruption, crime
Inequality
Geopolitical stability
International relations
Migration
Reduce drivers of migration
National security

Critical natural infrastructure for climate security

Land-based ecosystems and **oceans** maintain **critical carbon and water cycles,** absorbing about half of the CO_2 emissions from fossil fuels and land use.

- **Biodiversity loss reduces resilience** to climate change, pushing ecosystems towards collapse.
- **Multiple stresses on ocean ecosystems** (acidification, climate change, overfishing, pollution, plastics) weaken the ocean biological carbon pump which could lead to loss of stored carbon
- **Cascading impacts** on global climate, regional rainfall, food & water security and social stability.



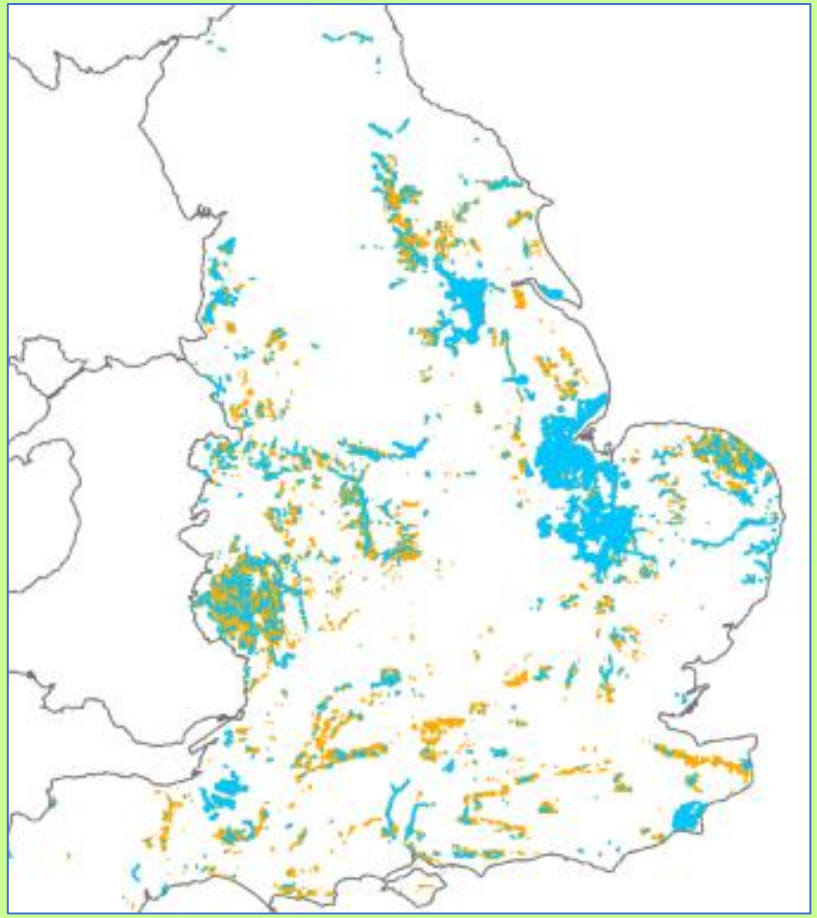
Friedlingstein et al 2025 Global Carbon Budget

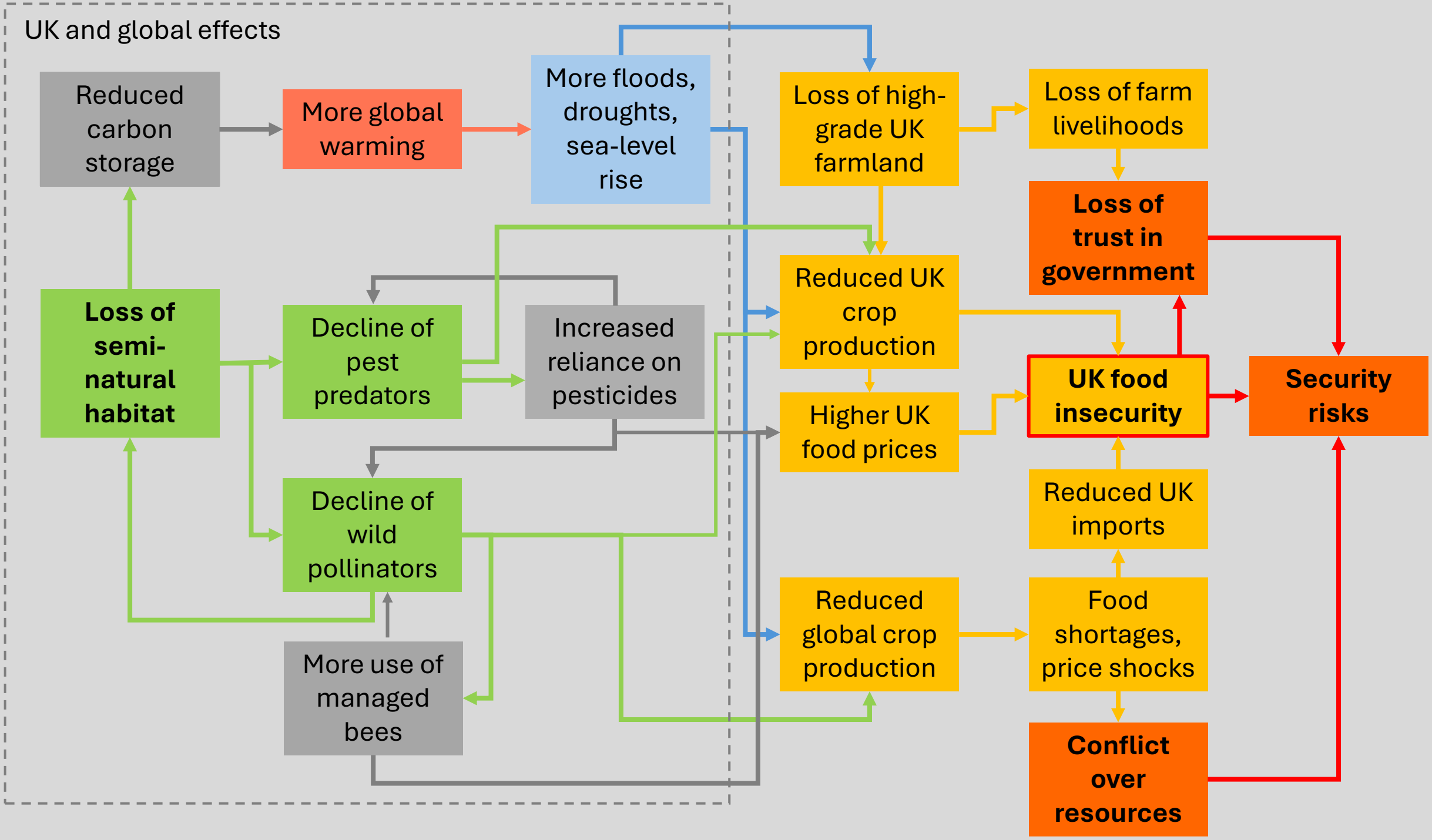
Critical natural infrastructure for UK food security

- Declining occurrence of **wild pollinators** (-18%) & **pest predators** (-34%) 1970-2020 in UK.
- Pollinator loss threatens UK fruit, vegetable & oilseed crops worth £1.7 billion /y
  - ❖Possible increase in farmland bees due to agri-environment schemes
- **Global pollinator decline**: severe risks for nutrition, food affordability, and economies of low-income countries reliant on exports (e.g. coffee, cocoa), could trigger political instability.
- **Compounding risks:**
  - 59% of Grade 1 farmland at risk of **floods**
  - Fens and much Grade 1-2 land also suffering **water scarcity**

Grade 1 farmland (England)

In Flood Zone 3 (59%)
Not in Flood Zone 3 (41%)




UK and global effects
Reduced carbon storage
More global warming
More floods, droughts, sea-level rise
Loss of high-grade UK farmland
Loss of farm livelihoods
Loss of trust in government
Loss of semi-natural habitat
Decline of pest predators
Increased reliance on pesticides
Reduced UK crop production
Higher UK food prices
UK food insecurity
Security risks
Decline of wild pollinators
More use of managed bees
Reduced UK imports
Reduced global crop production
Food shortages, price shocks
Conflict over resources

Nature-based solutions for resilience and security

Carbon storage, health, biodiversity

Coastal flooding and erosion	Inland flooding and erosion	Water supply and quality	Heatwaves	Food security

Coastal & marine

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

Natural flood management (NFM)

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

Marine protected areas, seagrass, kelp, etc

Green and blue infrastructure

- Sustainable drainage (SuDS), constructed wetlands
- Urban trees and green spaces, green roofs & walls

Agro-ecology

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

Nature-based solutions: from cascading risks to cascading benefits

Uplands	Lower slopes	Farmland	Floodplains	Urban	Coastal
• Peatlands • Leaky dams	• Woodlands • Leaky dams	• Agroforestry • Agroecology • Hedgerows • Nutrients • Buffer strips	• River restoration • Floodplain reconnection • Wetland mosaics	• SuDS • Green roofs • Urban trees & parks • Constructed wetlands	• Seagrass • Saltmarshes • Coldwater reefs • Oceans



Garron Plateau: NI Water
Lower water treatment costs, reduced C emissions, improved flood protection
Cost: benefit ratio 1:4



Eddleston Water: Flood peaks 30% lower, avoiding £950,000 of damage. Benefits for carbon, water quality & recreation £4.2 million over 100y.



Sustainable Drainage Systems: keeping stormwater out of combined sewers

Reducing pollution, protecting coastal & marine ecosystems



Resilient landscapes for pollinators & pest predators: “weeds” & “scrub”

Top ten plants for pollinators (based on number of visits):

Creeping buttercup
Creeping thistle
Common hogweed
Ragwort
Cow parsley
Brambles
Oxeye daisy
Wild parsnip
Blackthorn
Common thistle

Wignall et al 2023 Food for flower-visiting insects: Appreciating common native wild flowering plants. *People and Nature*. 2023;5:1072–1081.











Societal resilience: Health and well-being benefits from access to nature

Health benefits provided by contact with nature

Mental health benefits	Physical health benefits
Reduced stress	Improved cardiovascular health
Better sleep	Improved congestive heart failure
Reduced depression	Lower blood pressure
Reduced anxiety	Reduced obesity
Greater happiness, wellbeing, life satisfaction	Reduced diabetes
Improved concentration and memory	Better eyesight
Restoration from mental fatigue	Improved pain control
Reduced ADHD symptoms	Improved immune function
Reduced aggression, less crime	Improved general health
Reduced schizophrenia	Reduced mortality
Increased social connectedness	Improved birth outcomes
Increased pro-social behaviour	Improved child development

https://www.agile-initiative.ox.ac.uk/wp-content/uploads/2023/03/Short_LevelUp_Policy_Brief_v5.pdf

2. Using data for smarter decisions: The Agile nature recovery opportunity maps

Options for field A: Grass, Orchard, Silvopasture, Silvoarable

Options for field B: Wetland mosaic

Options for field C: Natural regeneration, Silvopasture



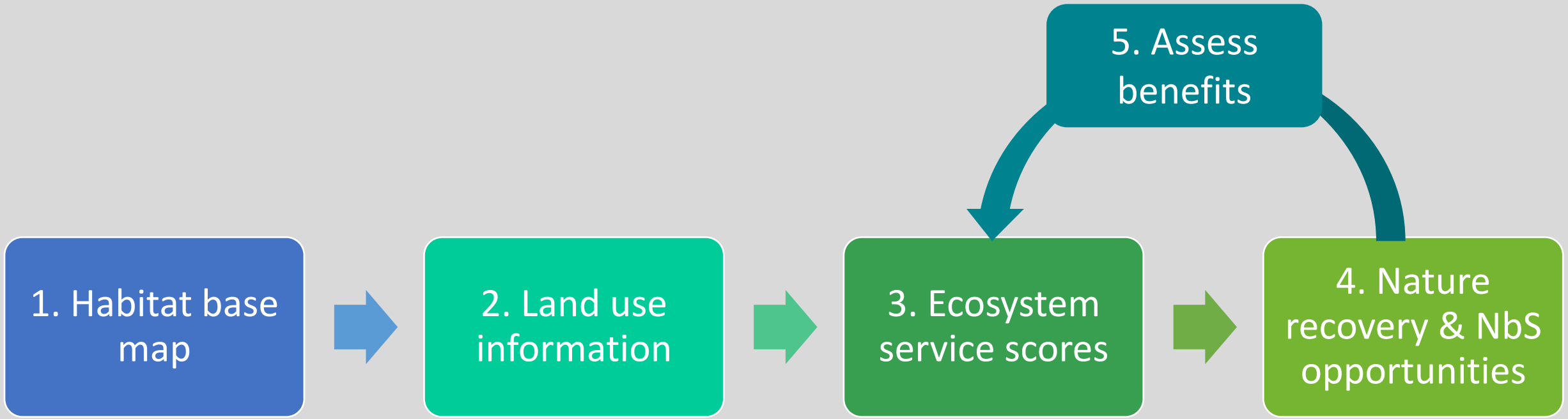
Main potential opportunities

- 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

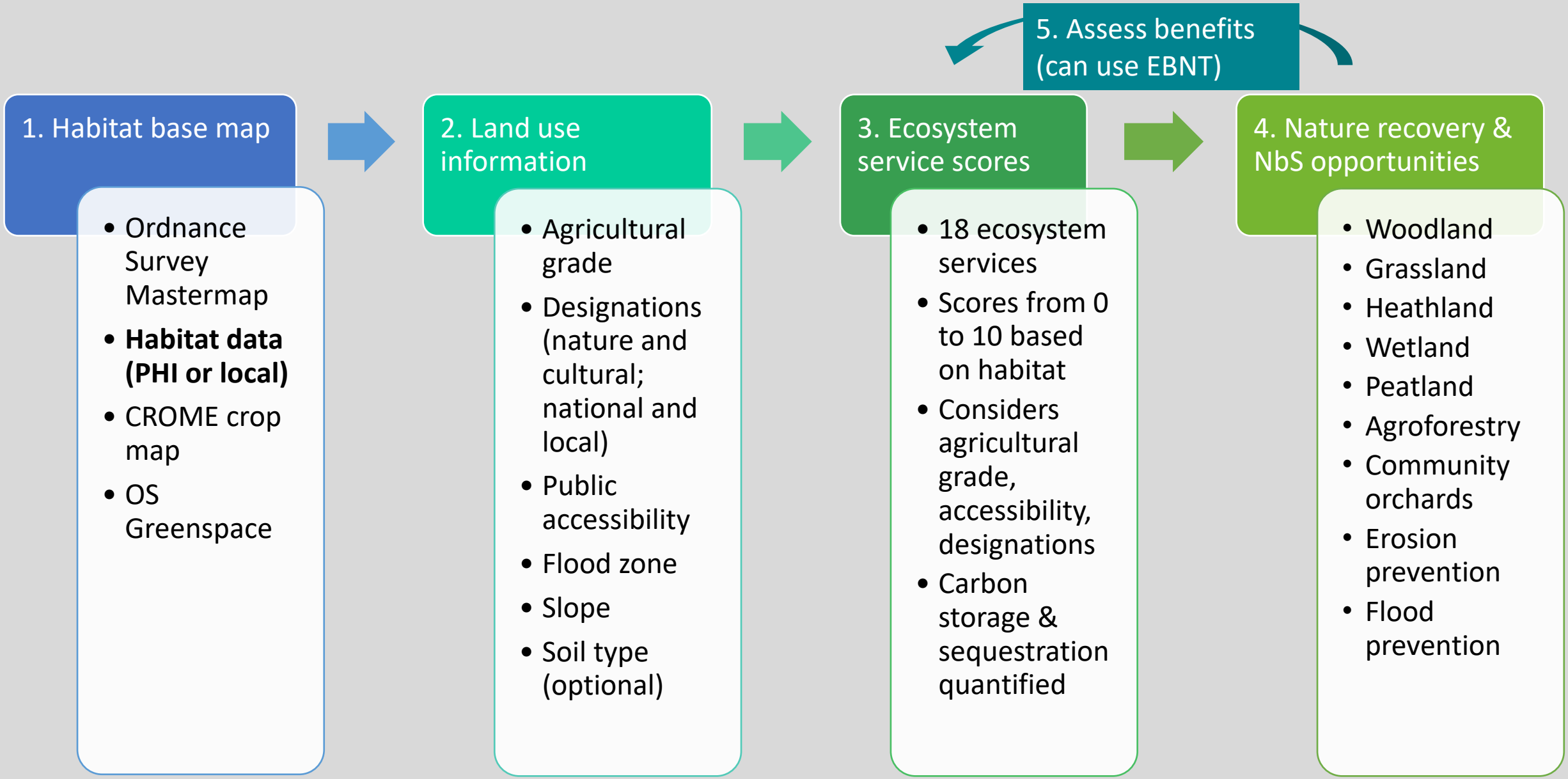
https://nbshub.naturebasedsolutionsinitiative.org/mapping-nbs-opportunities/

What are the Agile opportunity maps?



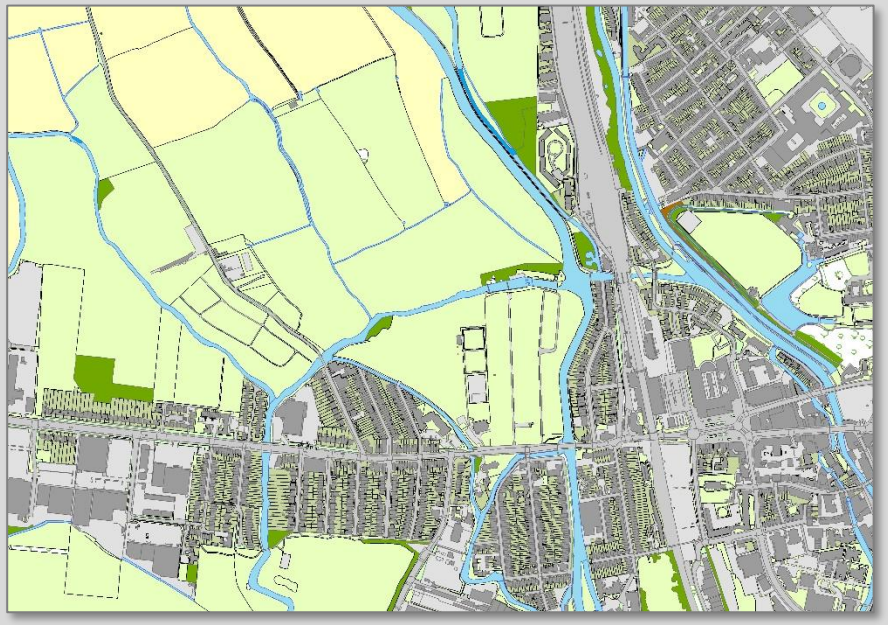
- Maps can be generated anywhere in England using freely available software
- Suggest suitable interventions for specific locations
- Intended to be used as part of a participatory process with local stakeholders
- First step - ground truthing essential!

Agile maps can be generated anywhere in England using free software



Agile habitat maps: complete and detailed coverage

OS Mastermap
complete coverage
less detail on natural habitats and farmland



Natural land
Agricultural land
Woodland
Water
Manmade surface
Building
Garden

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Local or national habitat and priority habitat data
excludes urban
more detail on semi-natural habitats



Arable
Improved grassland
Semi-natural grassland
Ephemeral / short perenni
Woodland
Water
Built up areas

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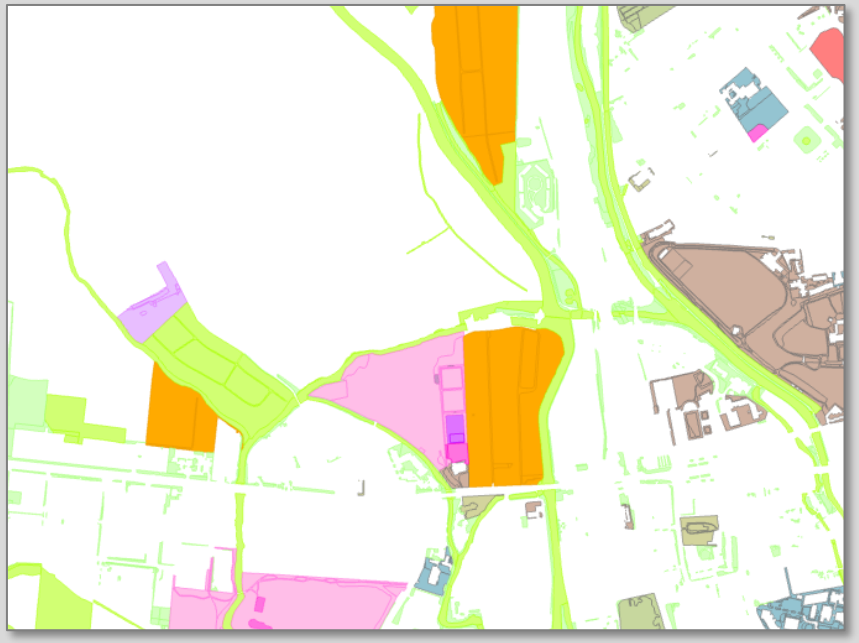
CROME Crop Map of England
Arable vs improved grassland



Agile habitat maps: complete and detailed coverage

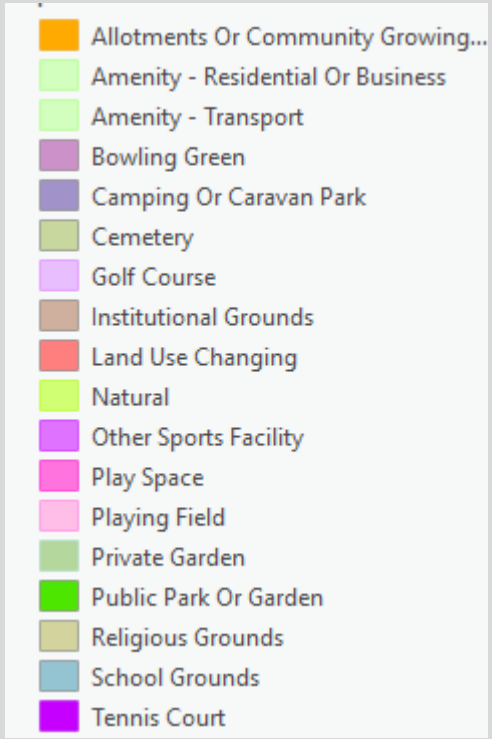
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OS Open Greenspace
OS Mastermap Greenspace



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Agile habitat maps
Complete detailed coverage



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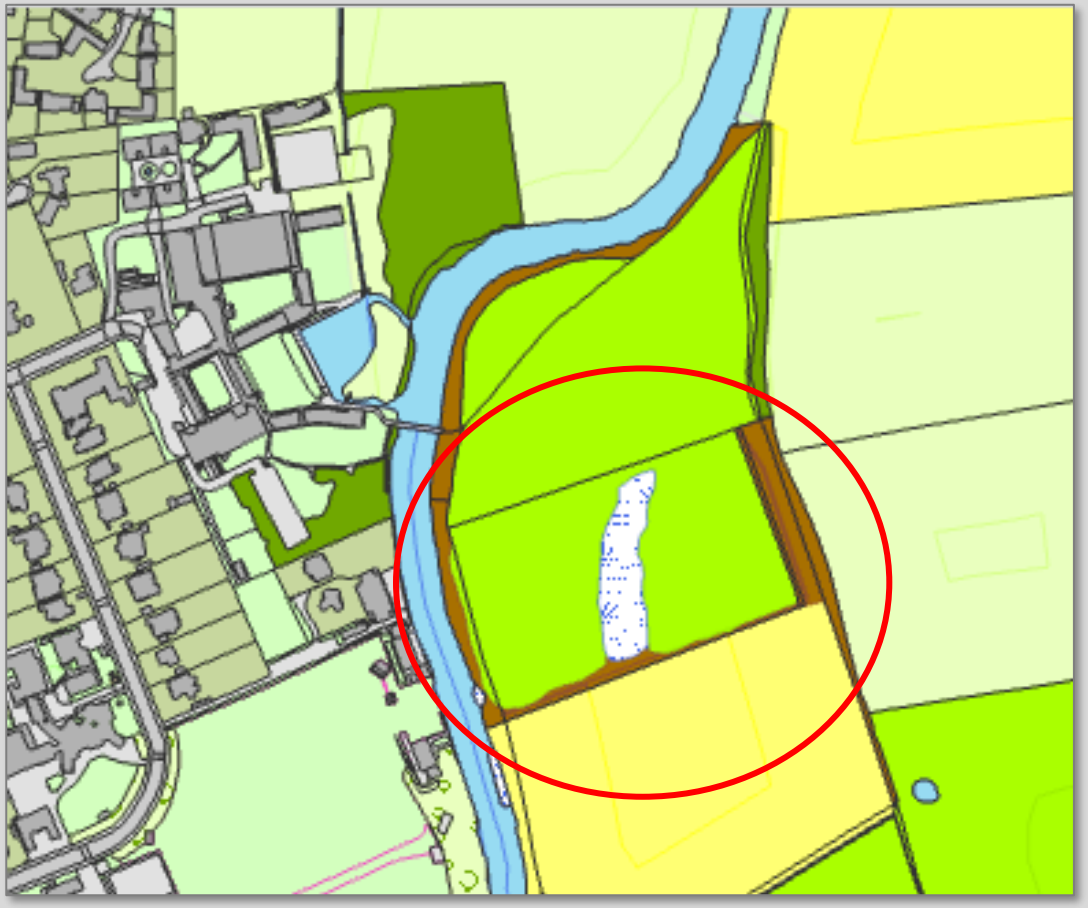
Agile maps match OSMM but include smaller habitat patches

OS Mastermap



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Agile map – shows additional wetland and scrub



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Ecosystem services are scored from 0-10 for each habitat

Cultural services

Recreation

Aesthetic value

Education and knowledge

Interaction with nature

Sense of place

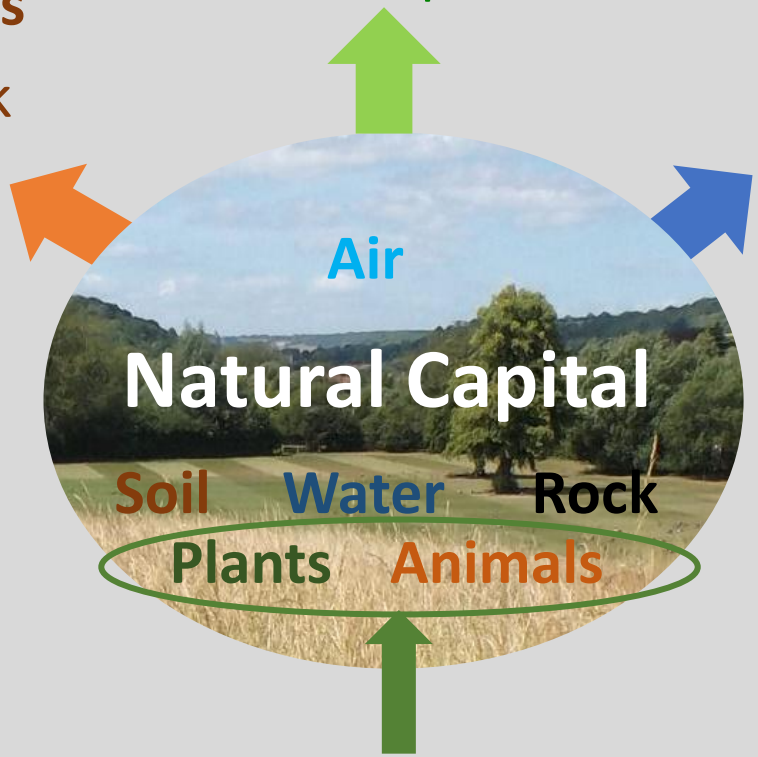
Provisioning services

Food crops, livestock

Wood

Fish

Fresh water supply



Regulating services

Flood control

Erosion control

Water quality

Carbon storage

Air quality

Cooling and shading

Noise regulation

Pollination

Pest control

Biodiversity underpins natural capital

Mapping opportunities for nature recovery and NbS

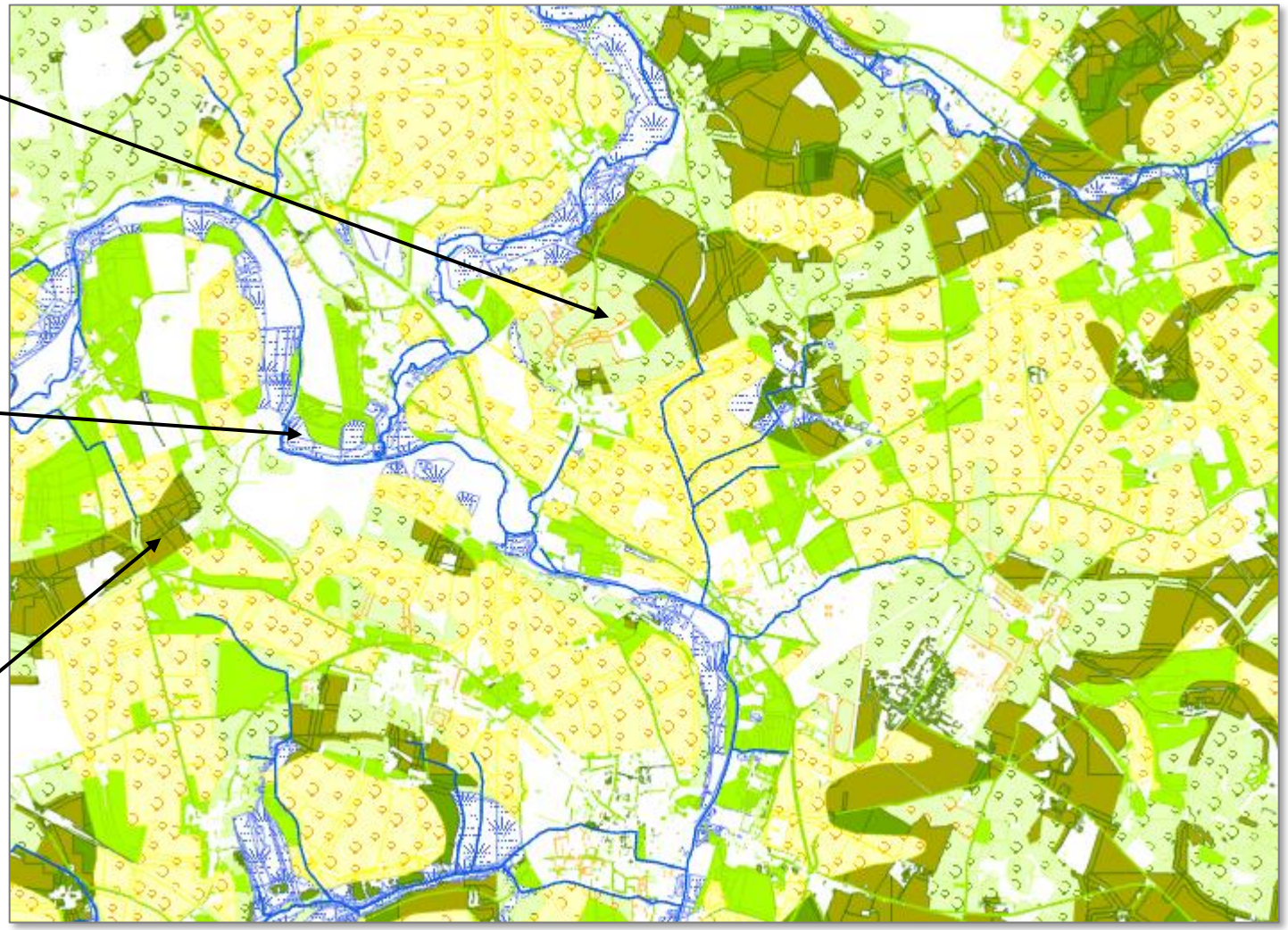
	Arable	Improved grassland	Amenity grassland	Poor semi-improved grassland	Bracken	Felled woodland	Semi-natural habitats	Deep Peat	Shallow peat and peaty pockets	Verges	ALC 1 or 2	Flood zone
Woodland	y	y	y	y	y	y	n	n	n	n	n	y
Grassland	y	y	y	y	y	y	n	n	y	y	If impr. grass	y
Heathland	y	y	y	y	y	y	n	n	y	n	n	y
Wetland	y	y	y	y	y	y	n	n	y	n	if peat	essential
Peatland	y	y	y	y	y	y	y	y	y	n	y	y
Silvoarable	y	n	n	n	n	n	n	n	n	n	y	y
Silvopasture	unless ALC 1 or 2	y	n	n	n	n	n	n	n	n	y	y
Community orchard	y	y	y	y	y	y	n	n	n	n	n	y

2. Using data for smarter decisions: The Agile NbS Opportunity Maps

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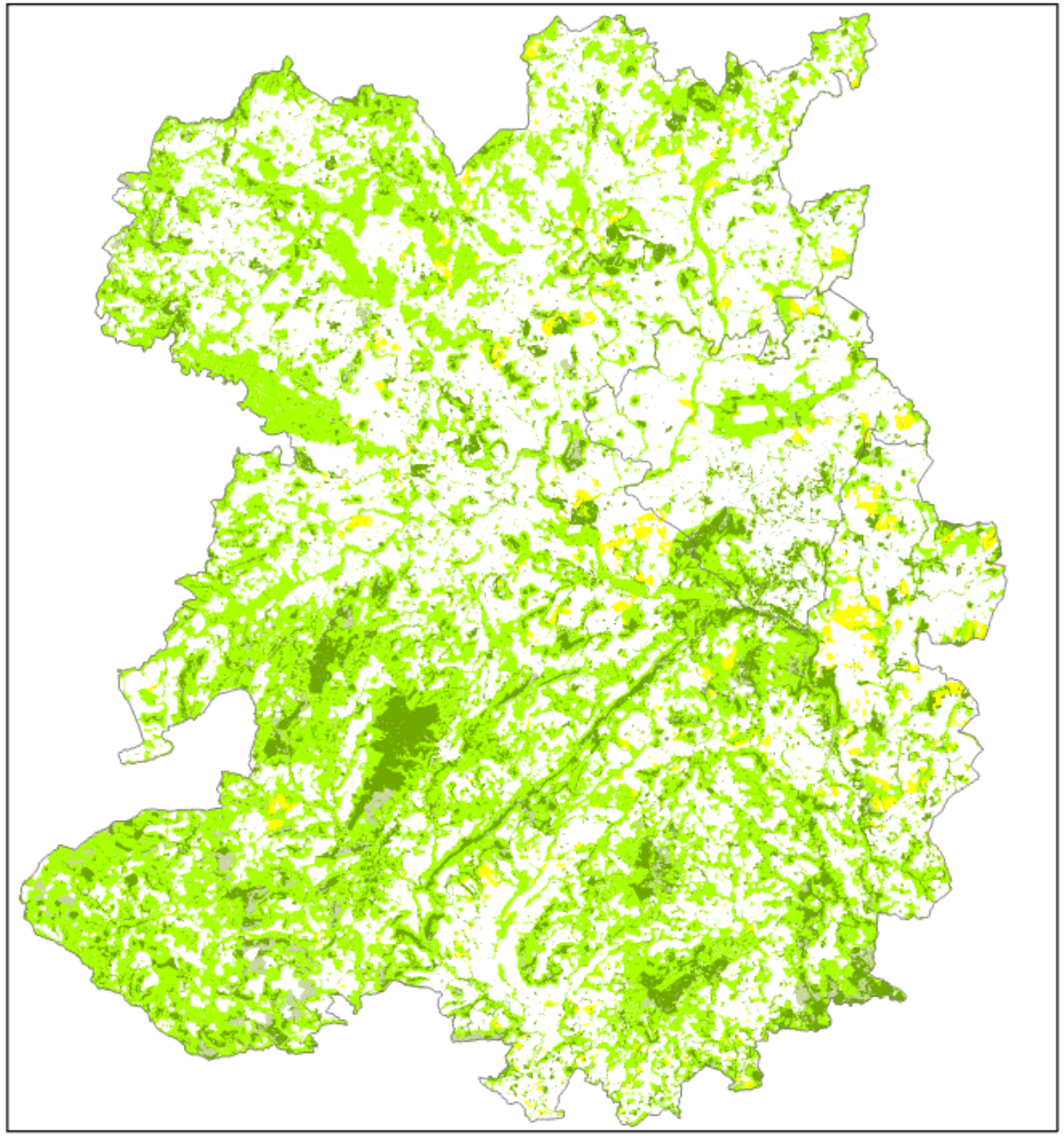
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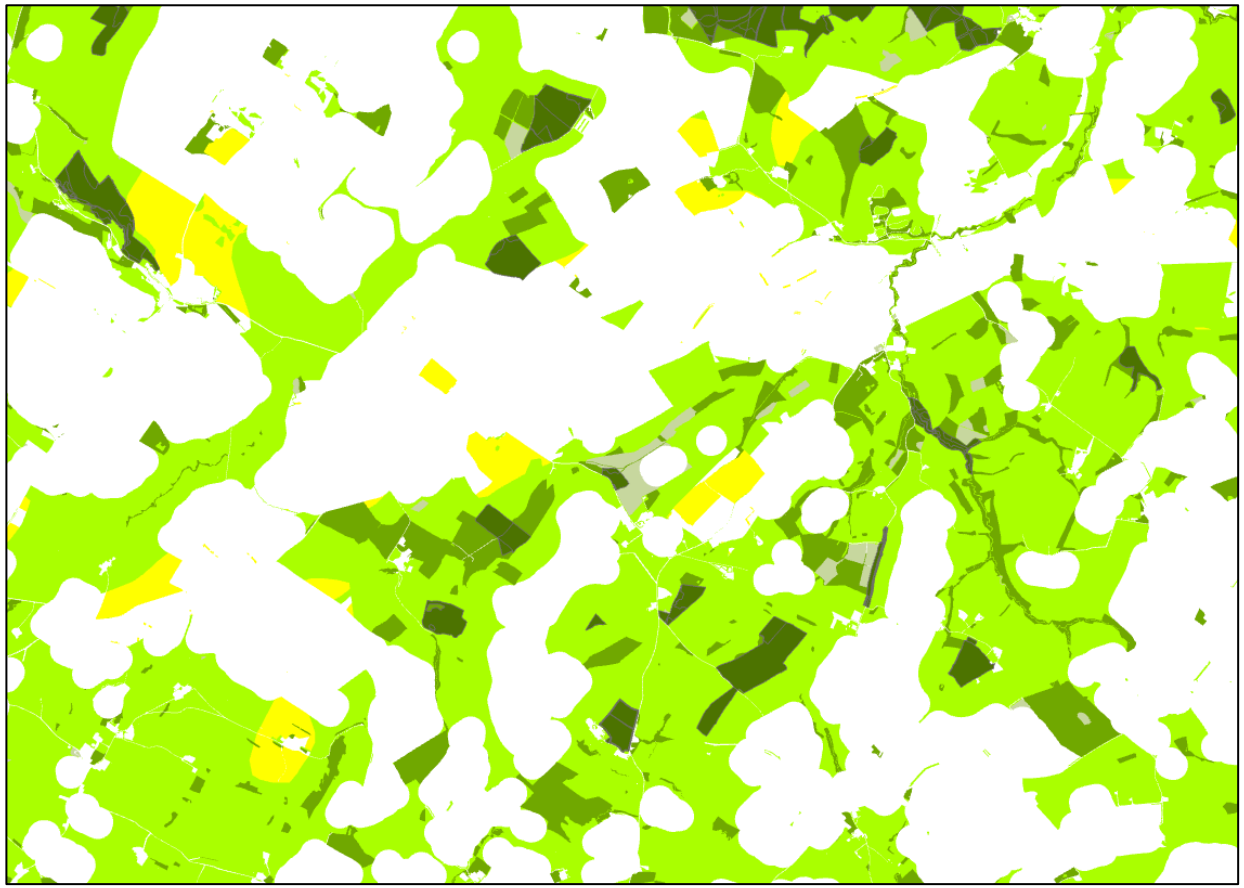
https://nbshub.naturebasedsolutionsinitiative.org/mapping-nbs-opportunities/

Agile maps used for the Shropshire LNRS

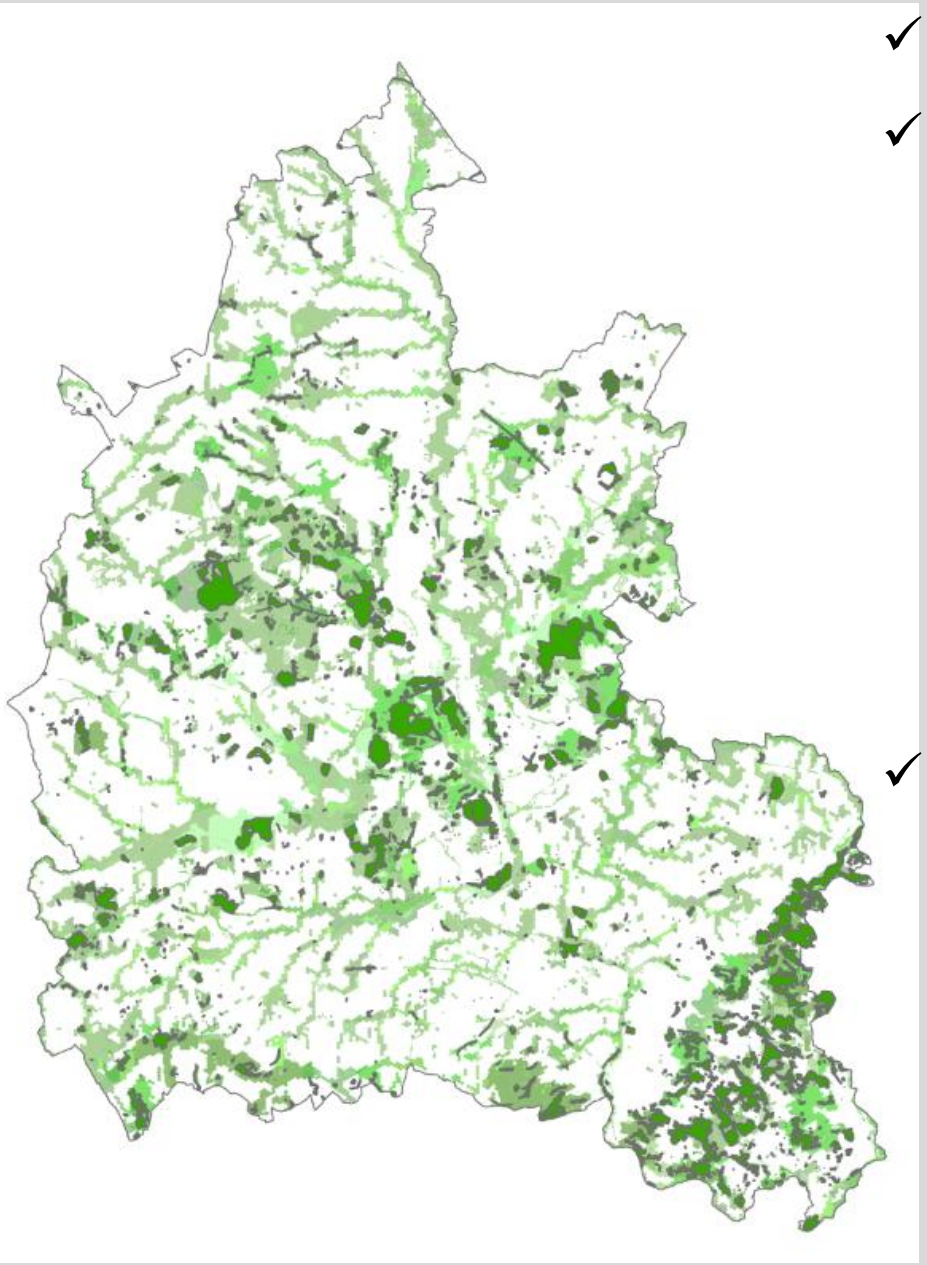


Priority_type
- High grade farmland: agroecology options
- Nature recovery opportunity
- Other land use
- Protect existing habitat

Core designated areas



Oxfordshire's Local Nature Recovery Strategy



- ✓ **Connects core wildlife sites into a network**
- ✓ **Maps opportunities to restore a wide range of local ecosystems that support local species**
  - Woodlands, hedgerows, scrub
  - Chalk grassland
  - Floodplain meadows, wetlands, ponds
  - Heathland
  - Parkland with scattered trees
  - Tree-grass-scrub mosaics
- ✓ **Designed in consultation with local communities**



Water vole



Dormouse



Little owl



Adder



Meadow Clary



Using the Agile maps to develop an integrated carbon-nature strategy for Oxfordshire

Started from LNRS. Removed constraints using Agile map: man-made features, water, existing semi-natural habitats, existing plantations, Grade 1 and 2 farmland.

Prioritisation:

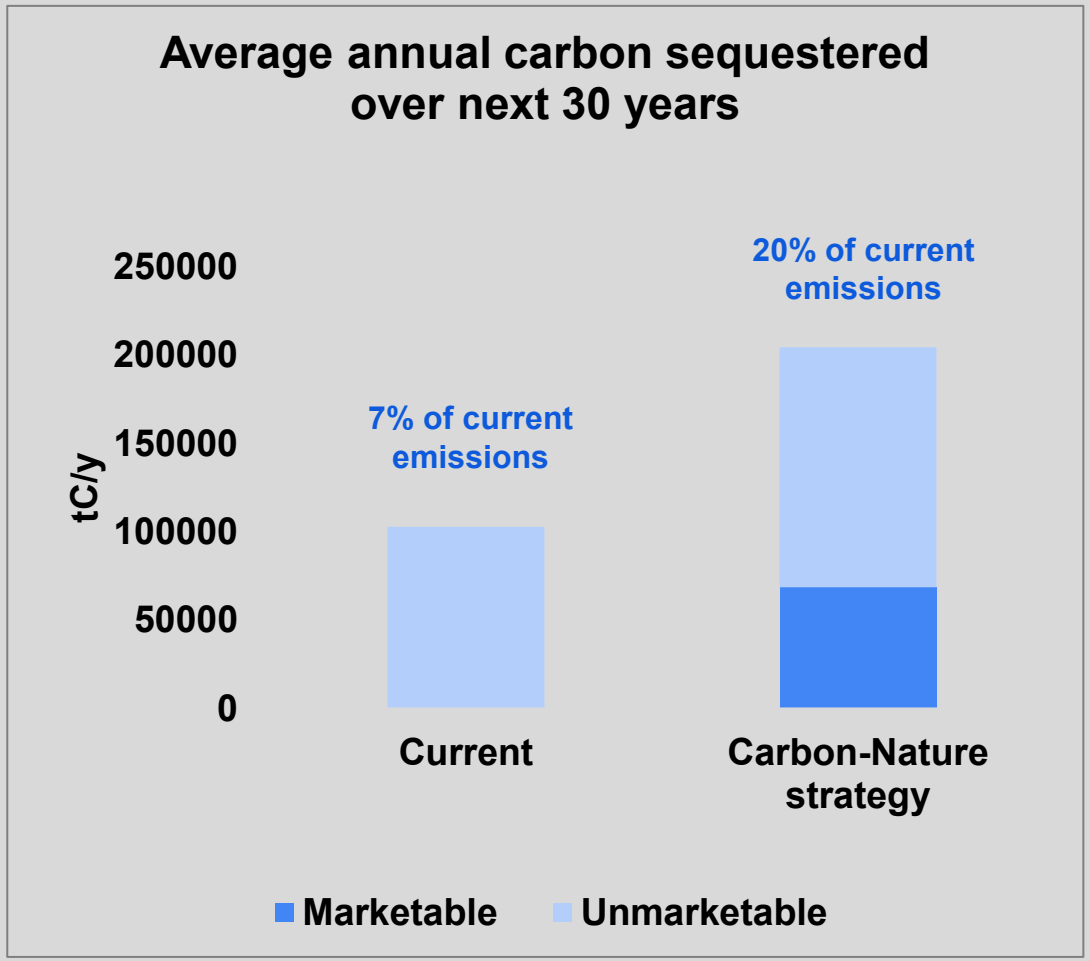
1. **Peatland restoration** on degraded peat soil (very little in Oxfordshire)
2. **Broadleaved native semi-natural woodland**: within 200m of existing woodland, not on floodplain.
3. **Wet woodland**: within 200m of existing woodland, on the floodplain but not on 'marshy grassland' (potentially biodiverse).
4. **Wood-grass-scrub mosaics:** intersection of woodland and grassland opportunities
5. **Other habitats allocated in order of scarcity**: heathland, acid grassland, lowland meadows (on floodplain), lowland fens, calcareous grassland, neutral grassland, traditional orchards, silvopasture, silvoarable.
6. **High grade farmland** (Grade 1 or 2) was allocated to silvoarable or silvopasture.
7. **Beyond the LNRS network:** 40% increase in **hedgerows; agroecological practices** enhance soil carbon on all arable land

Wider benefits from Oxfordshire's LNRS: Agile maps and the EBNT tool

42% gain in biodiversity (BNG units)

Carbon sequestration doubles

Only 34% is marketable (WCC, Wilder Carbon, future hedgerow, agroforestry, orchard & soil carbon codes)



13 out of 18 ecosystem services increase but food production decreases

Whole area	1 year	10 year	30 year
Food production	↘	↘	↘
Wood production	→	→	↗
Fish production	→	→	→
Water supply	→	→	→
Flood regulation	→	↗	↗
Erosion protection	↗	↗	↗
Water quality regulation	↗	↗	↗
Carbon storage	→	→	↗
Air quality regulation	→	→	↗
Cooling and shading	→	→	↗
Noise reduction	→	→	→
Pollination	→	↗	↗
Pest control	→	↗	↗
Recreation	→	→	→
Aesthetic value	→	↗	↗
Education	→	↗	↗
Interaction with nature	→	↗	↗
Sense of place	→	↗	↗

Informing policy: Maximising benefits and minimising trade-offs

- **Address trade-offs with food production:** Increase productivity, reduce food waste and shift to more plant-based diets.
- **Protect new habitats and manage sensitively.** Oxfordshire LNRS encourages minimum intervention: deadwood left in situ, some scrub on grasslands, natural regeneration.
- **Tree-grass-scrub mosaics and naturally regenerated woodland** are structurally diverse and can be better adapted to local conditions and more resilient to change.
- **Target greenspace-deprived areas to maximise public health benefits** (balance with disturbance risk)
- **Nature-based solutions**:
  - Woodlands upstream of flood-risk zones and on slopes to tackle erosion.
  - Agroforestry and agroecology boost climate resilience to floods, droughts and heatwaves.
  - Grasslands and scrub provide habitat for pollinators and pest predators.

3. Looking ahead: where do we need more data and smarter policies?

Relevant policies

- Habitats regulations
- NPPF / **EDPs**
- **Local Nature Recovery Strategies**
- **Biodiversity Net Gain**
- **ELMs**
- Green Infrastructure Framework
- Land-Use Framework
- **Environmental Improvement Plan**
- Climate targets & policies
- Pollution regulations…..

Resilient landscapes

- Protected existing core habitats
- More habitat, bigger patches, connected
- Healthy, diverse, locally appropriate ecosystems
- Participatory governance; **local knowledge**
- **Monitored & adaptively managed**

Pressures on nature

- Habitat loss and fragmentation
- Over-exploitation (fishing, grazing, hunting, harvesting)
- Climate change
- Pollution
- Invasive species

Nature for resilience and security: key evidence needs

Policy priority	Evidence needs

Protect existing habitats	• Are interventions in the right place?
	  • Do they avoid damage to existing habitats and species?
	  • Do they support and connect existing species populations?
	• Is the management regime supporting the target species while also protecting other species?
	• **Are species recovering as a result?**

Restore habitats in line with the LNRS to meet the Environmental Improvement Plan (EIP) targets	
(Over) compensate for the damage caused by development (BNG and EDPs)	
Encourage nature recovery on farmland via ELMs payments	
Deliver nature-based solutions for food and climate resilience	

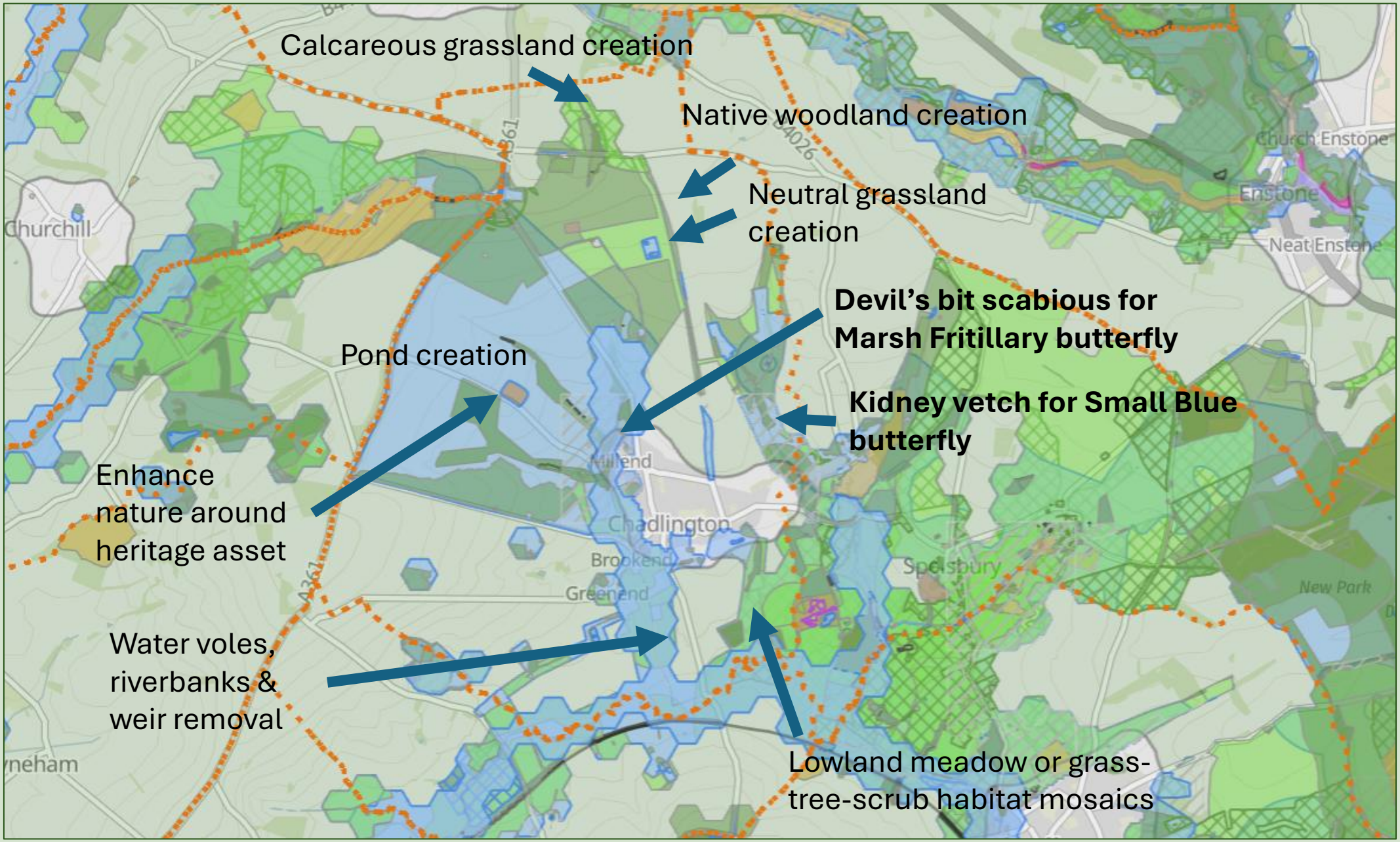
We need more emphasis on species: Oxfordshire LNRS Species Priority List

- **Amphibians**
  - Great crested newt.
- **Birds**
  - Bittern (and Marsh harrier), Breeding waders, Curlew, Farmland birds, Montagu's harrier, Nightingale, Stone curlew, Swifts and House martins, Tawny owl, Turtle dove, Willow tit.
- **Butterflies and moths**
  - Barberry carpet moth, Blackthorn butterflies, Dark green fritillary, Duke of burgundy butterfly, Liquorice piercer moth, Moths of Dyer's greenweed, Silver spotted skipper, Small blue butterfly, Striped lychnis moth, White admiral, White letter hairstreak, Wood white butterfly.
- **Fish, crustaceans, and snails**
  - Fish, White clawed crayfish, Desmoulin's whorl snail, Mountain bulin snail.
- **Fungi and Lichens**
  - Fungi and fungi-associated plants found with woodland, Lichens (on veteran trees).
- **Insects and spiders**
  - Beetle of Autumn gentian, Cigarello gall-fly, Clubbed general soldierly, Dung specialists and dung beetles, Ellipteroides alboscutellatus, Lousewort flea beetle, Meadow ant hoverfly, Noble chafer, Snail killing fly, Southern Damselfly, Spider (Tuberta maerens).
- **Mammals**
  - Bats, Beaver, Hazel dormouse, Hedgehog, Otter, Water vole.
- **Plants, flowers, and trees**
  - Black poplar, Creeping marshwort, Devil's bit scabious (and Marsh fritillary), Downy woundwort, Fen violet, Greater water-parsnip, Juniper, Limestone fern, Long-leaved helleborine, Meadow clary, Military orchid, Monkey orchid.
- **Reptiles**
  - Adder, Common lizard.

Oxfordshire LNRS Species Priority List

Water vole  Link to map	**Manage (or enhance) riverside banks, ditches, and watercourses for Water Voles.** This action can be to support existing Water voles, or to create suitable habitat for new water voles to colonise. Manage riverside banks, ditches, and watercourses to create or maintain areas of sunny shallow water margins with marginal and bankside vegetation and avoid excess or extensive overshadowing of the water by scrub or trees (especially if water vole colonies are already present). Avoid trampling or intensive grazing along the watercourse edge which can damage water vole burrows. Ensure that American Mink are being controlled with the aim to achieve their exclusion where water voles are present.
Small blue butterfly 	**Create and manage wide field margins and sheltered grasslands to contain Kidney Vetch (Anthyllis vulneraria) on low nutrient soils which get disturbed, to support Small Blue butterflies.** The Small Blue is England's smallest resident butterfly and requires habitat management to recover their numbers in Oxfordshire.

LNRS opportunities informed by species and habitat data



The Oxfordshire Local Nature Partnership: 8 strategic projects (seeking £)

















Summary

1. Nature underpins our food, water, health and climate security
2. Key policies affecting nature recovery include the LNRS, ELMS, BNG and planning policy
3. These all need to take more account of the impact on species, not just habitats

Policy priority	Evidence needs

Protect existing habitats	• Are interventions in the right place?
	  • Do they avoid damage to existing habitats and species?
	  • Do they support and connect existing species populations?
	• Is the management regime supporting the target species while also protecting other species?
	• **Are species recovering as a result?**

Restore habitats in line with the LNRS to meet the Environmental Improvement Plan targets	
(Over) compensate for the damage caused by development (BNG and EDPs)	
Encourage nature recovery on farmland via ELMs subsidies	
Deliver nature-based solutions for food and climate resilience	

Thank you

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https://www.agile-initiative.ox.ac.uk/sprints/environment-and-national-security/