

Looking at the big picture: aligning energy, climate, food, water and nature security

Alison Smith
Senior Researcher, Environmental Change Institute

Oxford Energy Seminar, *17 November 2026*

The Agile Initiative Research Sprint on:

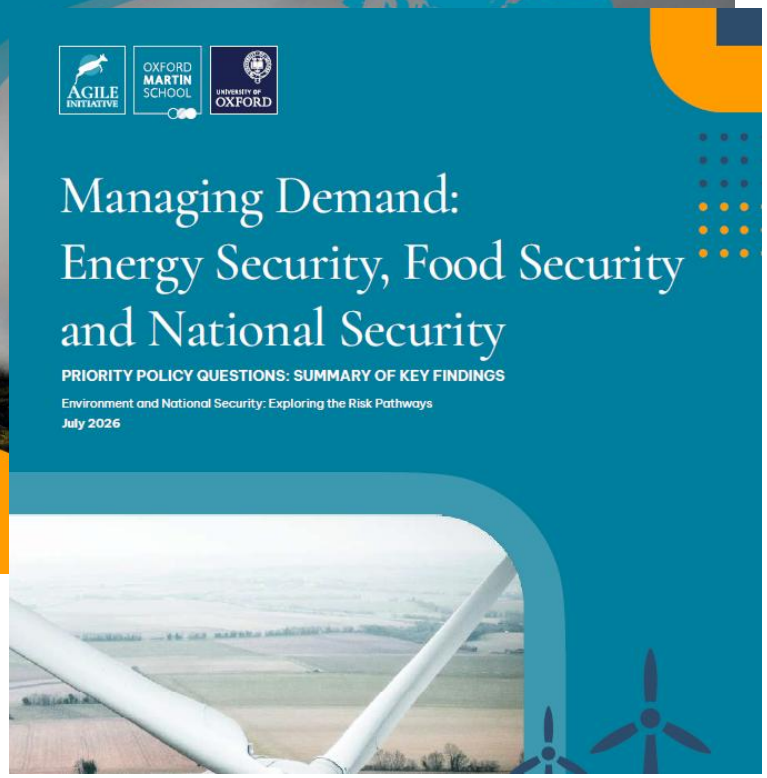
Environment & National Security

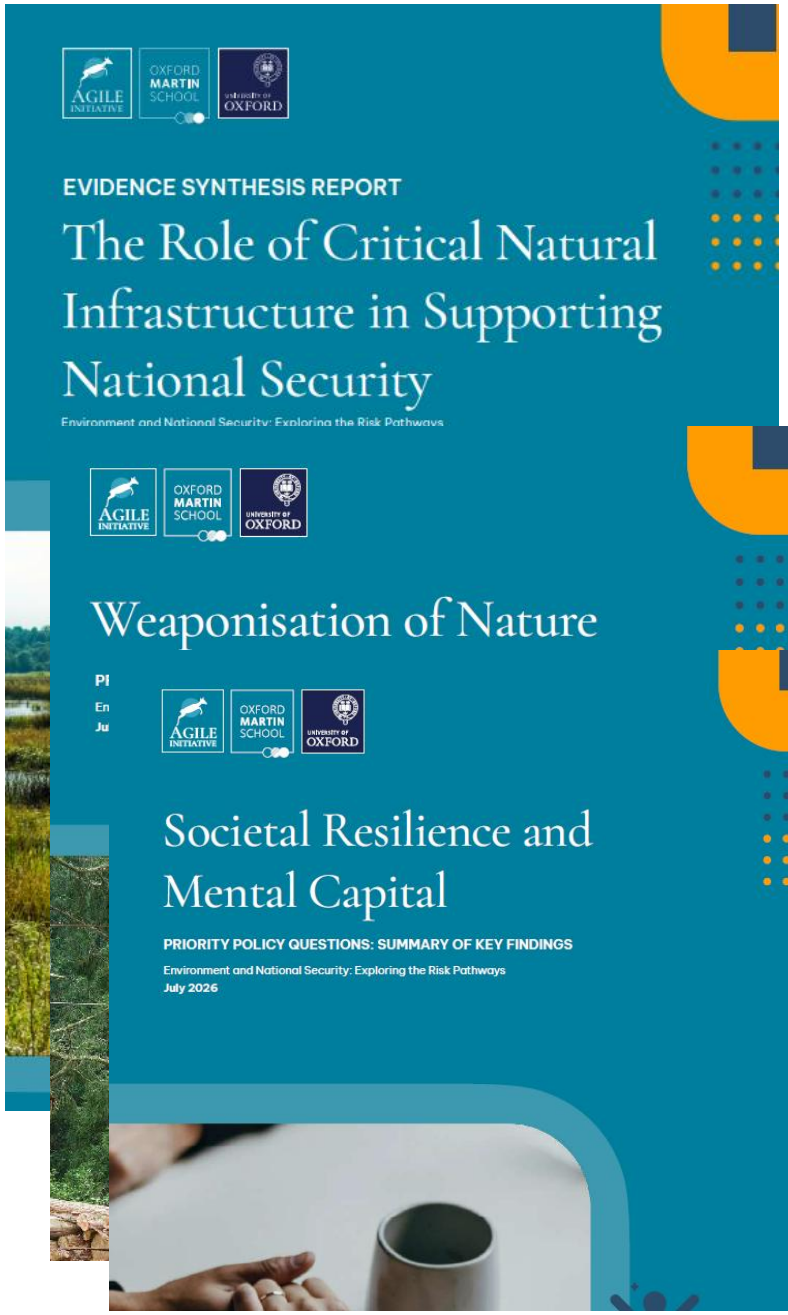
9 months Jan-Sept 2026

Evidence synthesis reports on

- Critical Natural Infrastructure
- Managing food & energy demand
- Weaponisation of nature
- Societal resilience
- Shipping and UK maritime trade







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

Outline



Vidar Nordli-Mathisen, Unsplash

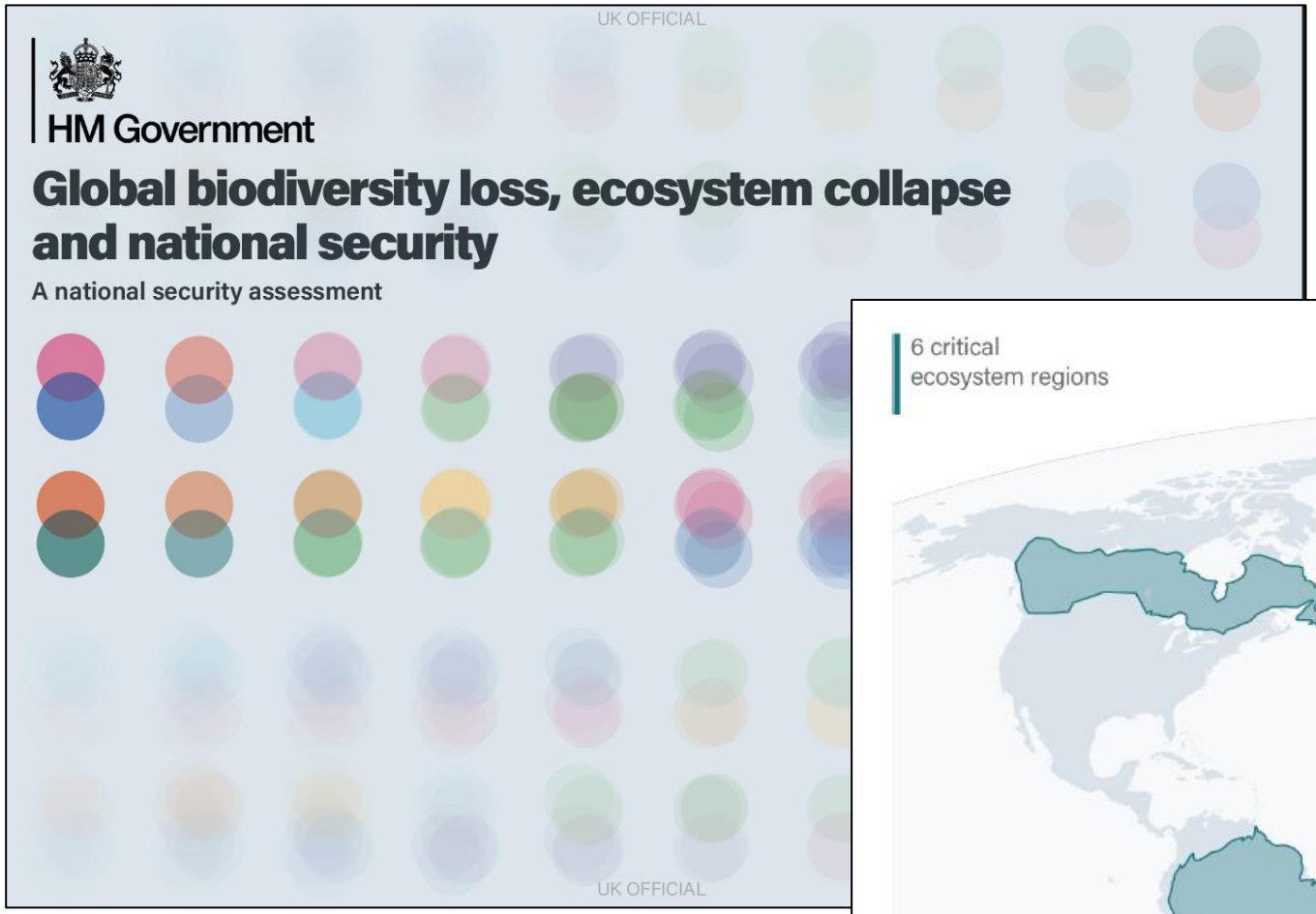
Environment and security: the big picture

Dependencies, conflicts and trade-offs between energy, climate, food, water & nature security

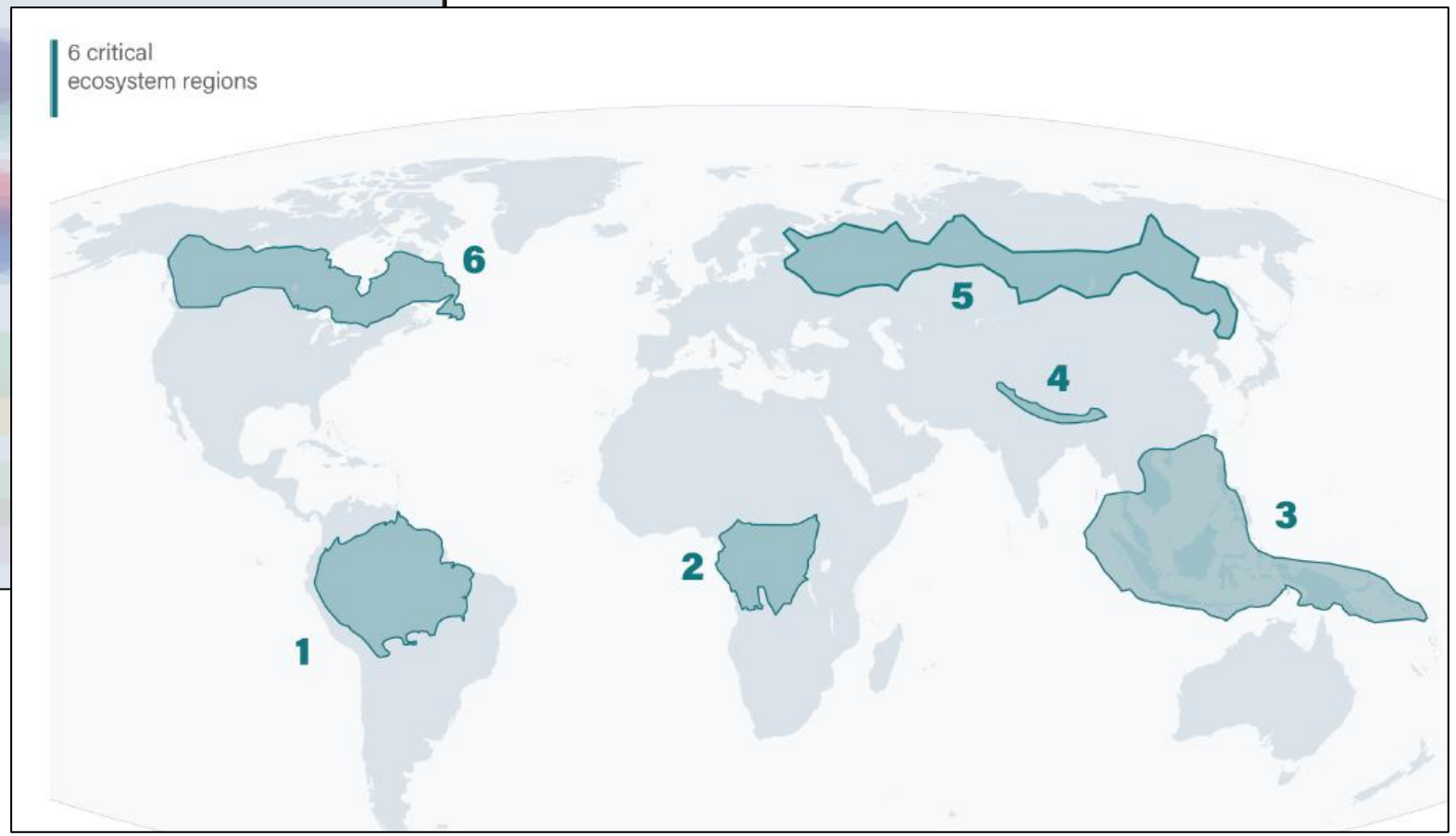
Interventions that reduce trade-offs and deliver multiple benefits

Recommendations

Environment and security: the big picture



"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

Ecosystem collapse is highly likely to drive national security risk

National security risks from ecosystem collapse

Migration will rise as development gains begin to reverse and more people are pushed into poverty, food and water insecurity. A one percentage increase in food insecurity in a population compels 1.9 percent more people to migrate.[3]

Serious and Organised Crime will look to exploit and gain control over scarce resources. More people pushed into poverty will mean more opportunities for SOC to exploit (e.g. people trafficking and black markets in scarce food, pharmaceuticals, critical minerals).

Non-state actors including terrorist groups will have more opportunities resulting from political instability - e.g. acting as mercenaries or pseudo-governments. They may gain control over scarce resources.

State threats become more severe as some states become more exposed than others to food and water insecurity risks.

Pandemic risk will increase as biodiversity degrades, people move between countries and transfer of novel diseases between species becomes more likely.

Economic insecurity becomes more likely. Nature is a finite asset which underpins the global economy. It would take resources of 1.6 Earths to sustain the world's current levels of consumption.[14] The total annual value of ecosystem services to the UK was £87 billion in 2022 (3% of GDP).[15]

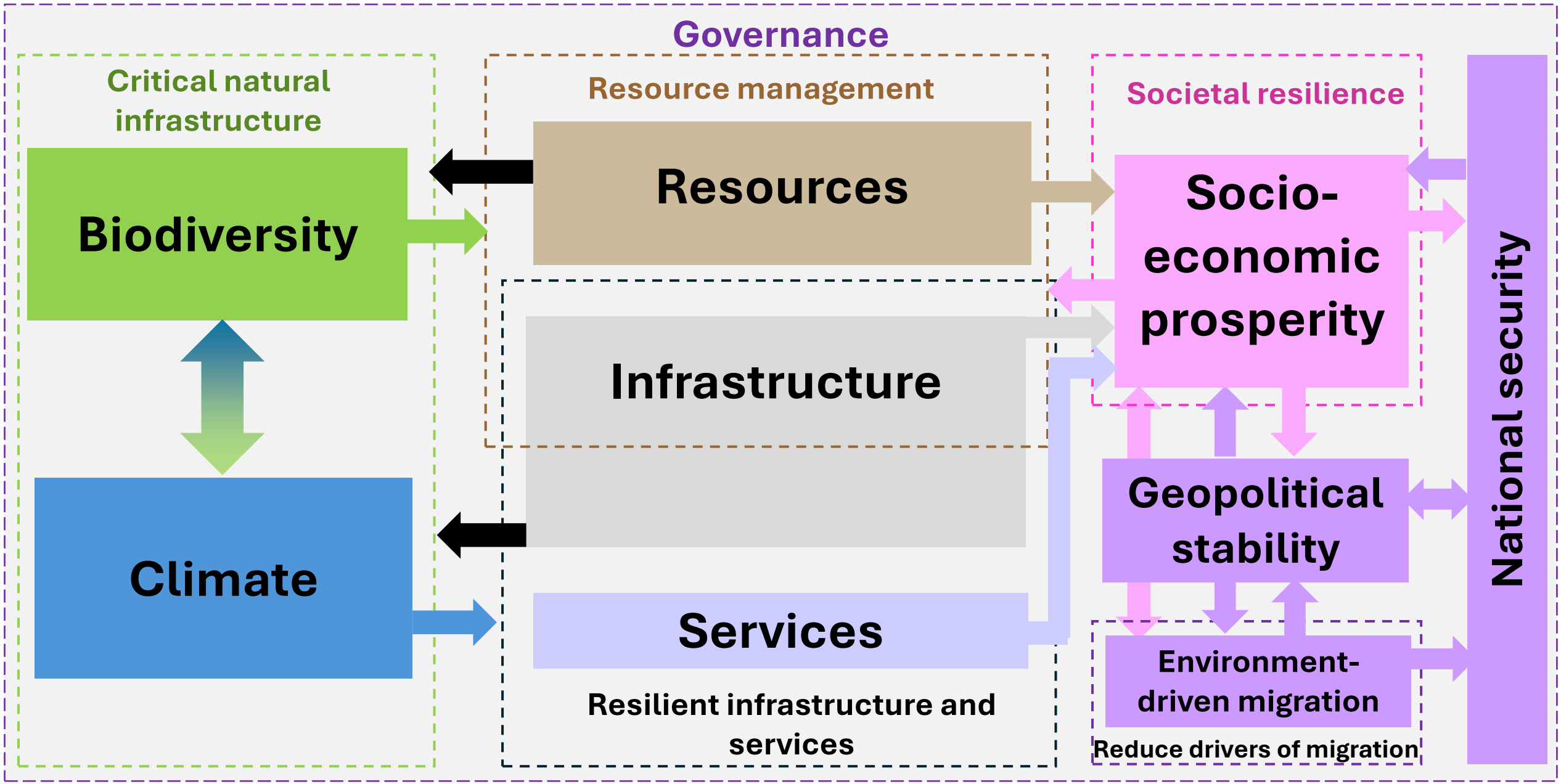
Geopolitical competition will increase as countries compete for scarce resources including arable land, productive waters, safe transit routes, critical minerals.

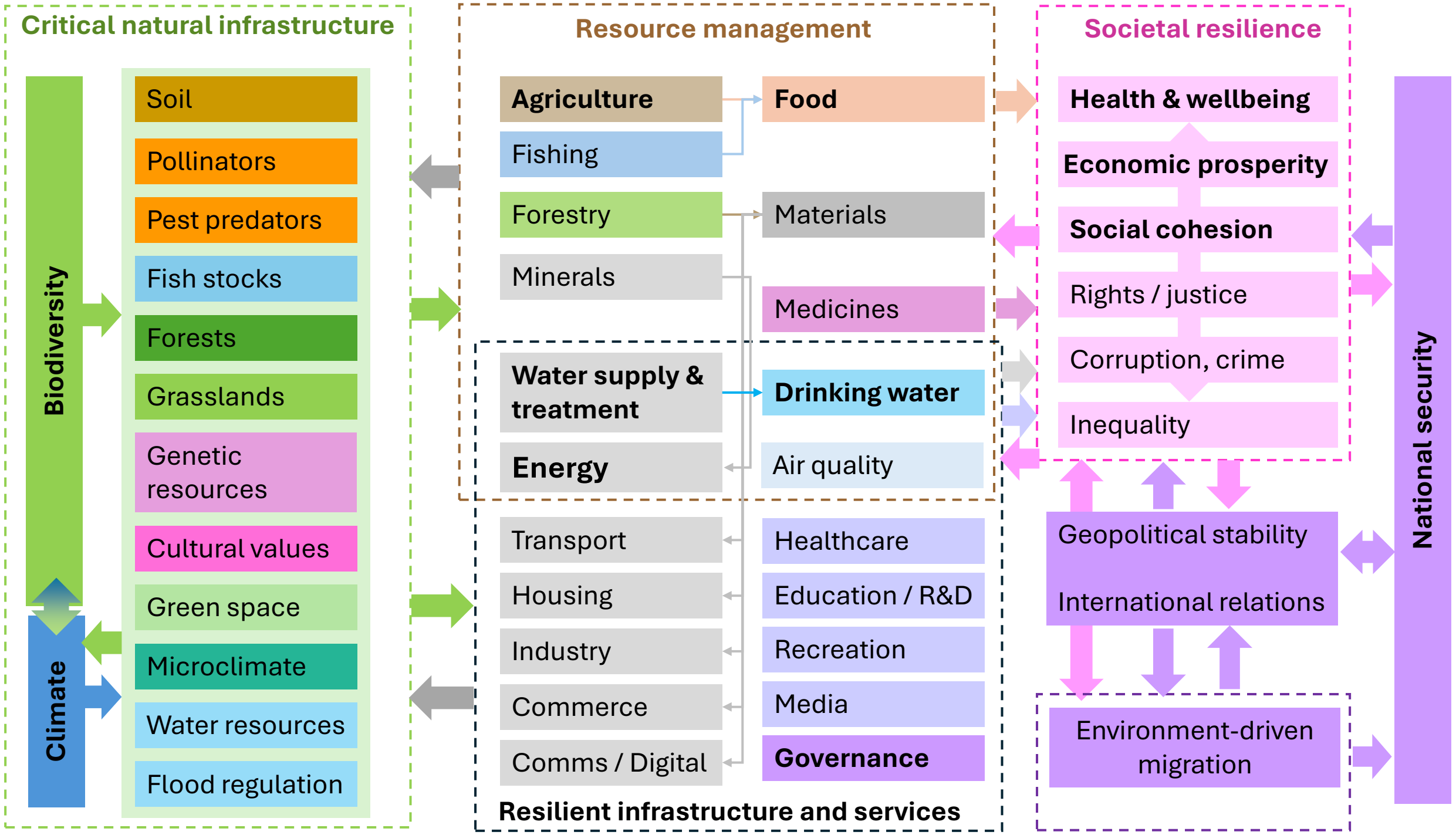
Political polarisation and instability will grow in food and water insecure areas and as populations become more vulnerable to natural disasters. Disinformation will increase.

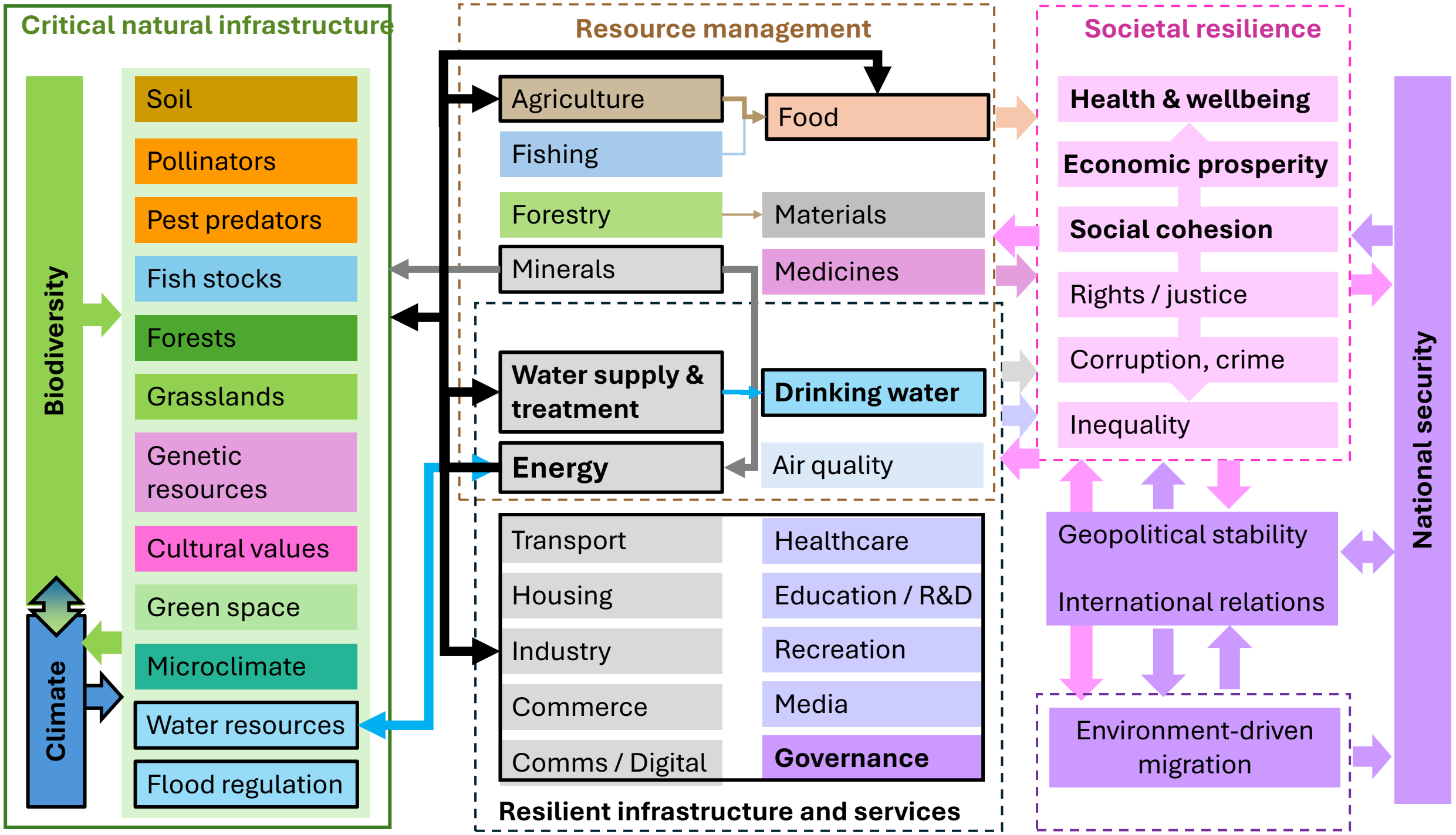
Conflict and military escalation will become more likely, both within and between states, as groups compete for arable land and food and water resources. Existing conflicts will be exacerbated.

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

Environment and security: the big picture




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


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

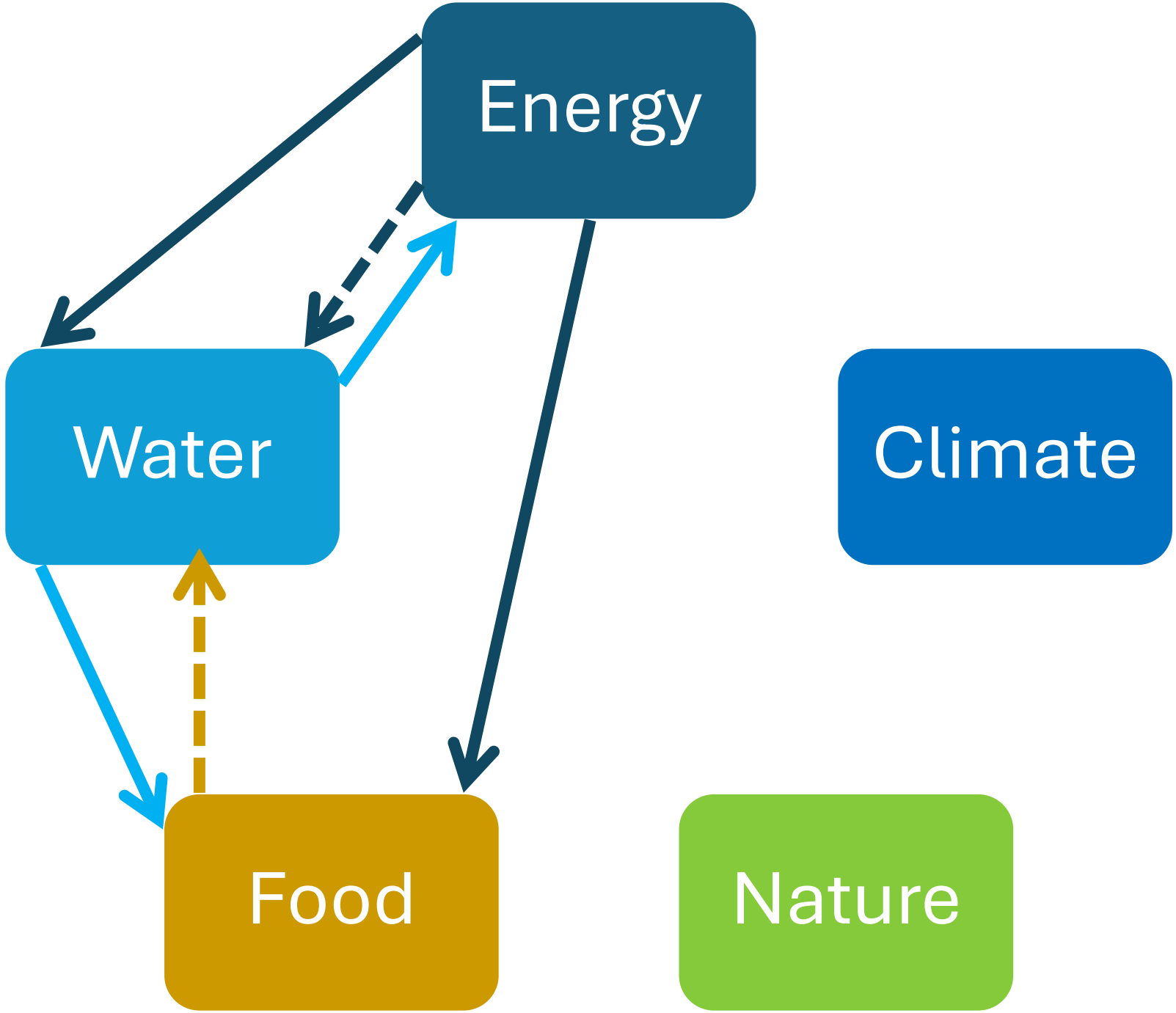
Main dependencies, conflicts & trade-offs

Essential input

Negative impacts

Mixed impacts

Food production uses about 30% of global energy consumption
https://www.fao.org/energy/en



Energy and food security

Energy shocks can become food shocks:

- Energy is needed for farm machinery, fertiliser production, transport, processing, storage & cooking

Farmers fear future as fertiliser and fuel bills soar



Photo by Chris Ensminger on Unsplash

Soaring diesel prices take their toll on US farmers in midwest corn belt

Fuel costs are biting for crop growers, trucking firms and a host of other industries as Iran war stokes record prices

'Fertiliser costs mean I'm better off not planting,' says farmer

A farmer says rises in the cost of fertiliser since war began in the Middle East mean he is better off not using it.

India's fertiliser supplies under strain as war disrupts shipments

In Thailand's rice paddies, rising petrol prices spell chaos for farmers

Shropshire farmer to pay extra £25K on fertiliser due to Iran war

Rory Lay spent £77,000 on fertiliser in 2026, compared to £52,000 for the same quantity in 2025.

Energy and water security

Energy needs water:

- Water is needed for cooling power plants and hydropower.
- High-CCS decarbonisation scenarios use more water than high-renewables.

Water needs energy:

- Energy is needed for extracting, treating and distributing water
- Energy demand for desalination could quadruple from 2010 to 2030, mainly in the Middle East

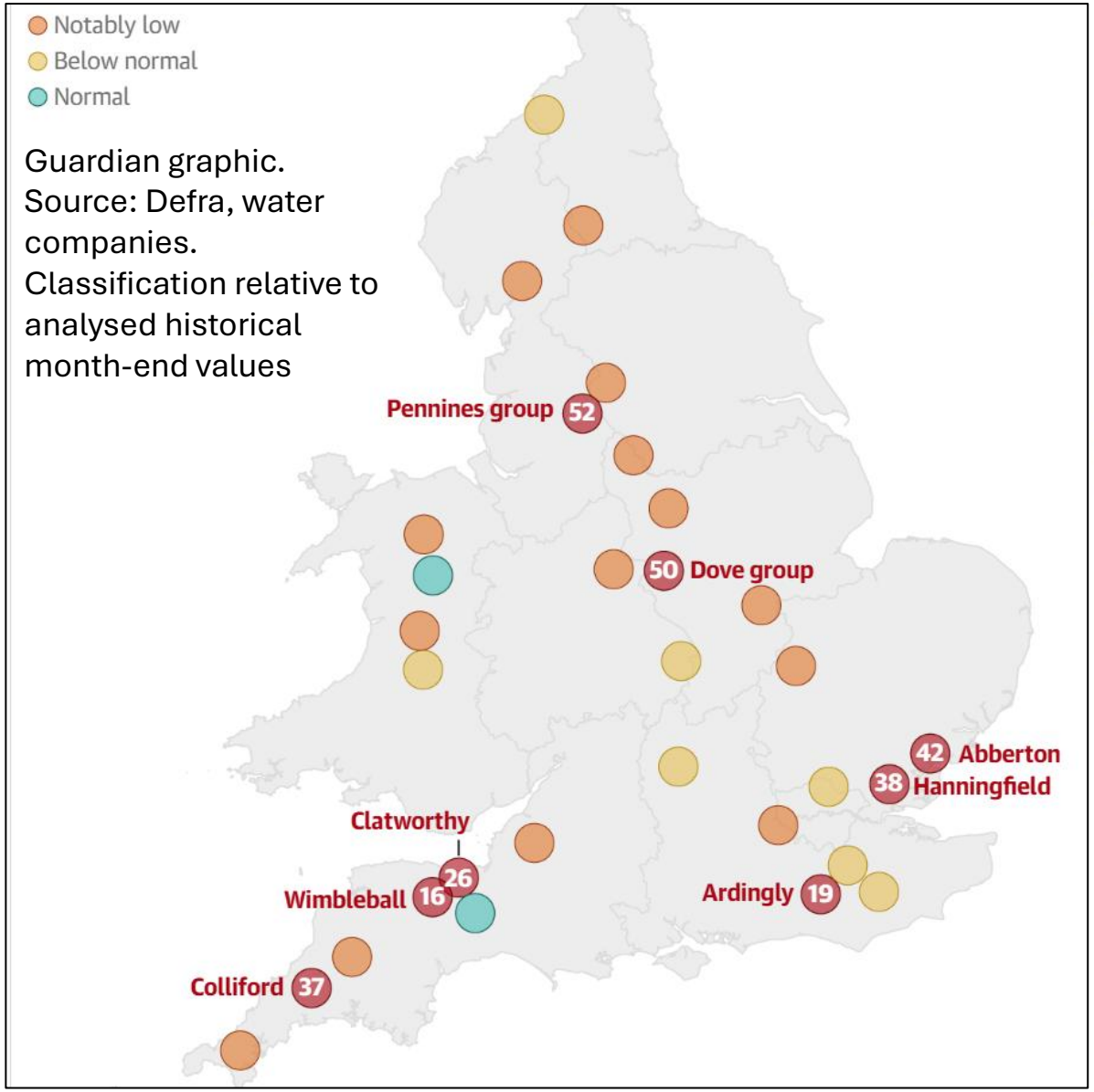
Energy demand drives water scarcity:

- The global energy system used around 10% of total freshwater withdrawals in 2021.
- Power plants and data centres put stress on water supplies, especially in droughts

In England, there could be a public water supply deficit of up to 5 billion litres a day by 2055



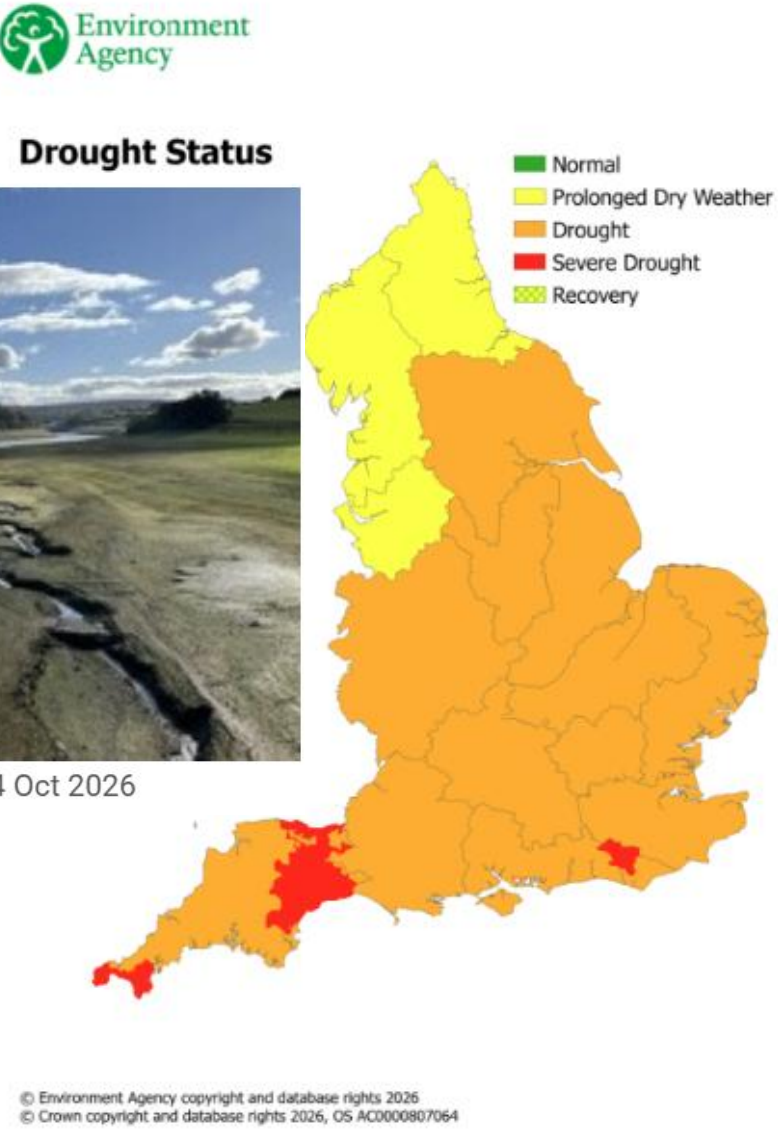
Reservoir levels in England, 15 October 2026



https://www.theguardian.com/environment/2026/oct/15/severe-drought-declared-six-areas-england-public-water-supplies-threat



Wimbleball Reservoir 14 Oct 2026



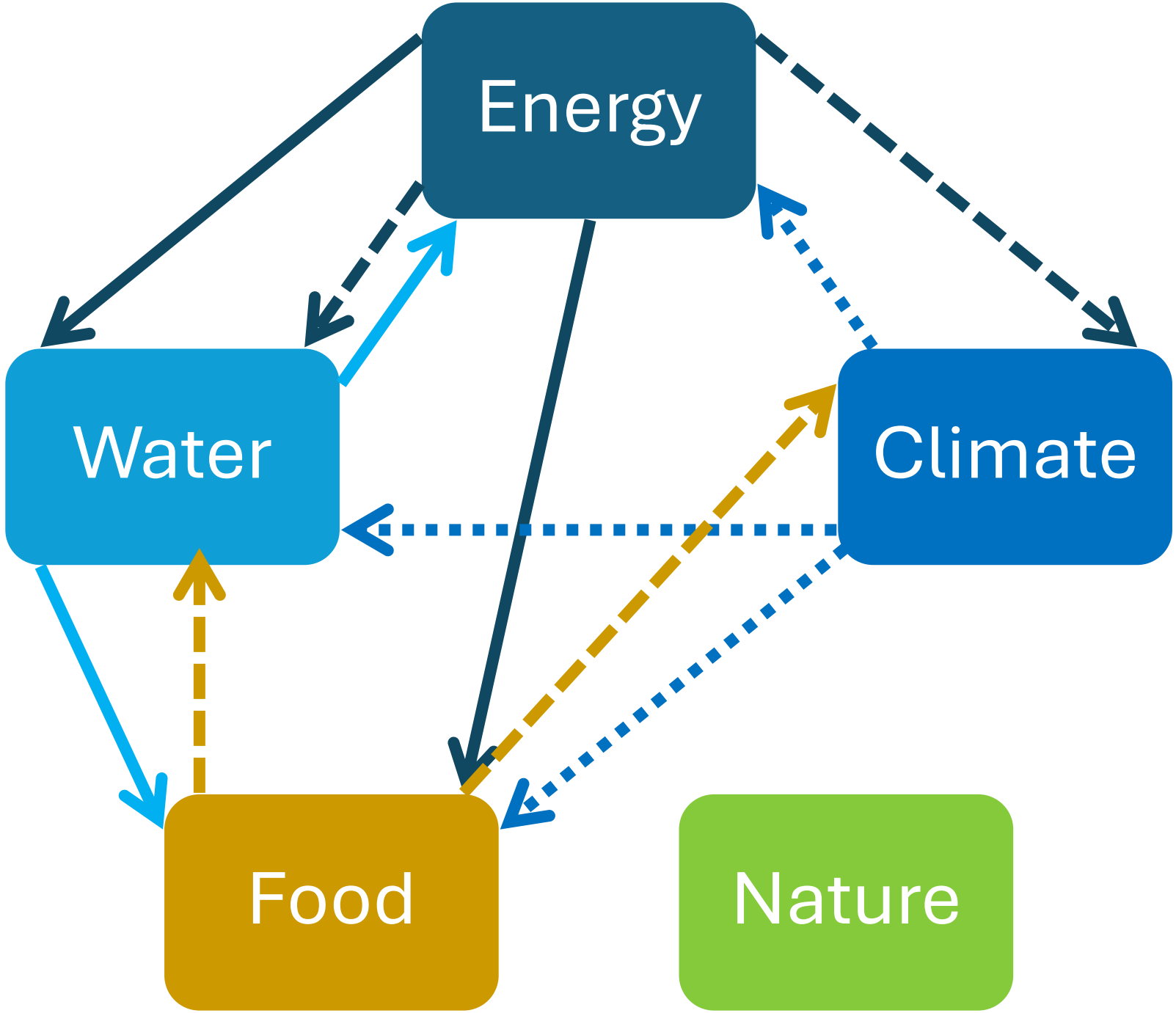
https://engageenvironmentagency.uk.engagementhq.com/dry-weather-information-2025

Main dependencies, conflicts & trade-offs

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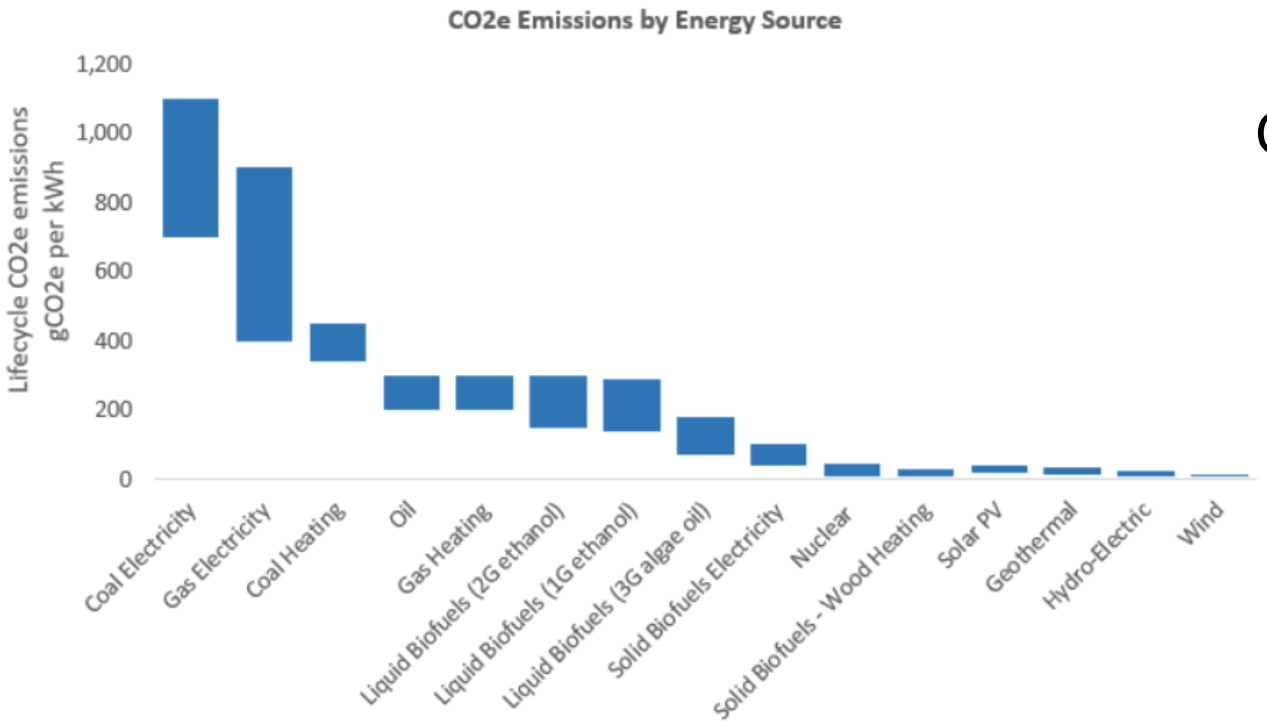


Food production uses about 30% of global energy consumption and produces 31% of GHGs
https://www.fao.org/energy/en

Energy produces about 80% of GHGs

Energy and climate security

Energy use causes GHG emissions and hence climate change



https://net-zero.blog/book-blog/energy-supply-and-lifecycle-emissions

Climate change can increase energy use

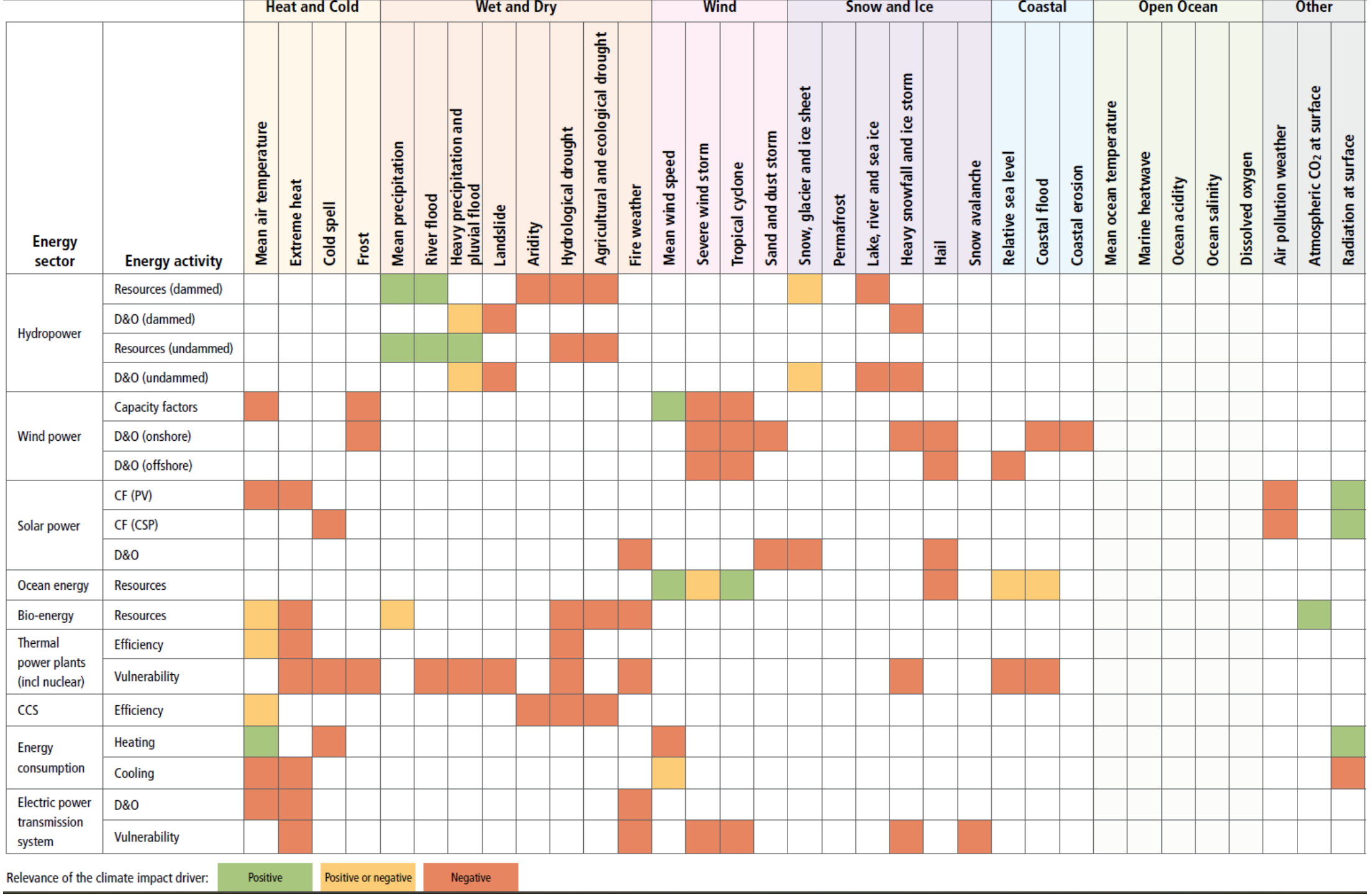
- Air conditioning
- Repair of damage after floods and storms
- Heating can go up or down

Climate change causes energy supply shocks



IPCC AR6

Impacts of climate change on energy



		Heat and Cold				Wet and Dry								Wind				Snow and Ice						Coastal			Open Ocean					Other		
Energy sector	Energy activity	Mean air temperature	Extreme heat	Cold spell	Frost	Mean precipitation	River flood	Heavy precipitation and pluvial flood	Landslide	Aridity	Hydrological drought	Agricultural and ecological drought	Fire weather	Mean wind speed	Severe wind storm	Tropical cyclone	Sand and dust storm	Snow, glacier and ice sheet	Permafrost	Lake, river and sea ice	Heavy snowfall and ice storm	Hail	Snow avalanche	Relative sea level	Coastal flood	Coastal erosion	Mean ocean temperature	Marine heatwave	Ocean acidity	Ocean salinity	Dissolved oxygen	Air pollution weather	Atmospheric CO_2 at surface	Radiation at surface
Hydropower	Resources (dammed)																																	
	D&O (dammed)																																	
	Resources (undammed)																																	
	D&O (undammed)																																	
Wind power	Capacity factors																																	
	D&O (onshore)																																	
	D&O (offshore)																																	
Solar power	CF (PV)																																	
	CF (CSP)																																	
	D&O																																	
Ocean energy	Resources																																	
Bio-energy	Resources																																	
Thermal power plants (incl nuclear)	Efficiency																																	
	Vulnerability																																	
CCS	Efficiency																																	
Energy consumption	Heating																																	
	Cooling																																	
Electric power transmission system	D&O																																	
	Vulnerability																																	

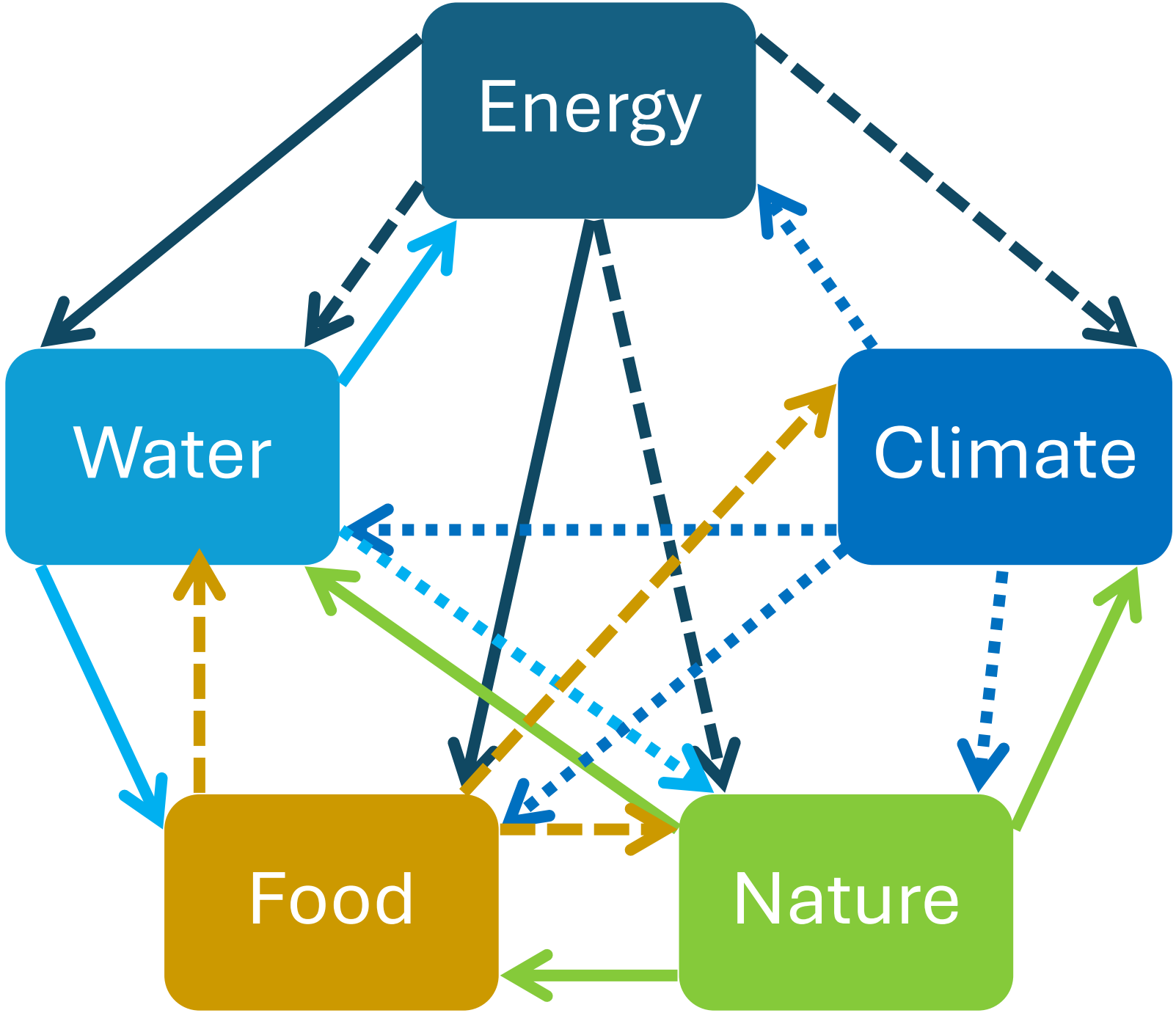
Relevance of the climate impact driver: Positive | Positive or negative | Negative

Main dependencies, conflicts & trade-offs

Essential input

Negative impacts

Mixed impacts



What has nature ever done for us?

Cultural services

Recreation

Aesthetic value

Education and knowledge

Interaction with nature

Sense of place

Climate change adaptation

Flood control

Erosion control

Cooling and shading

Fresh water supply

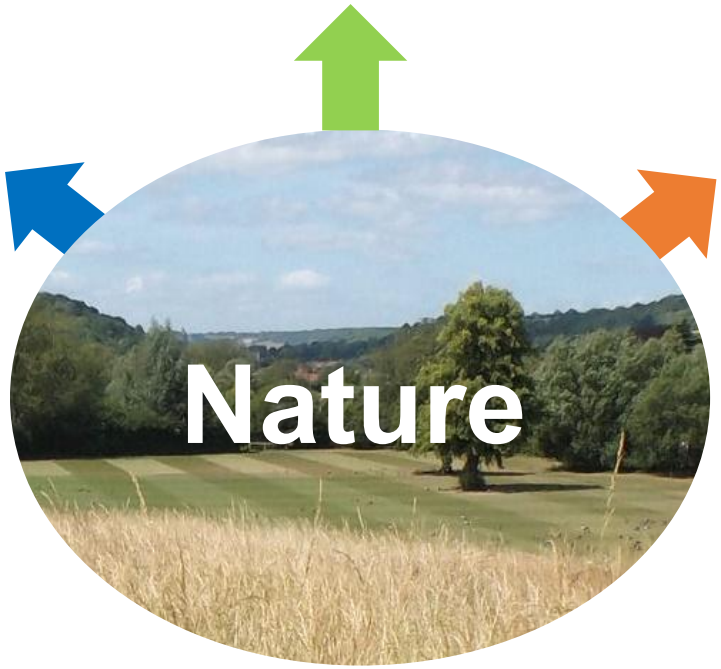
Mitigation of harm

Carbon storage

Water quality

Air quality

Noise regulation



Food and materials

Crops, livestock

Wood & fibre

Fish

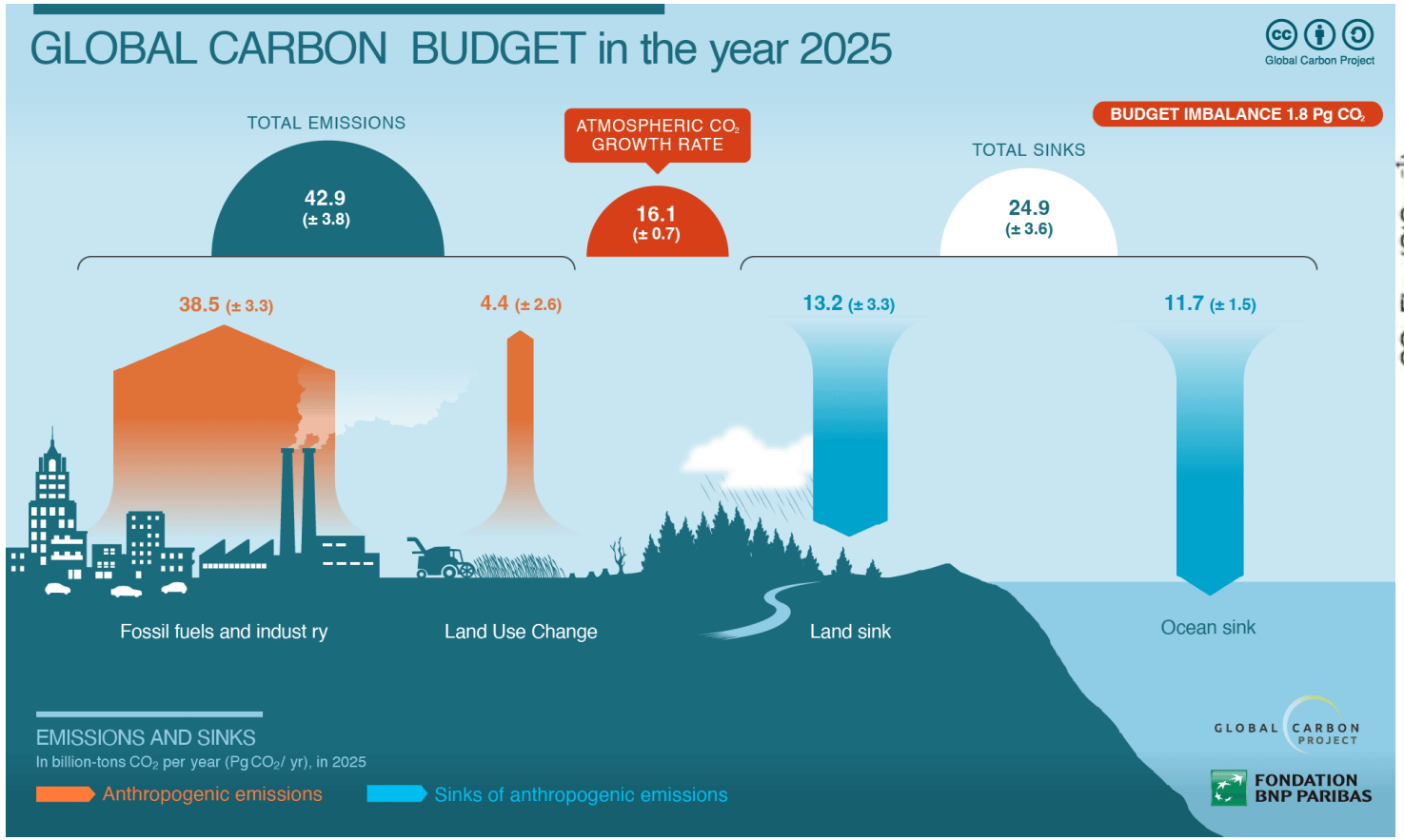
Pollination

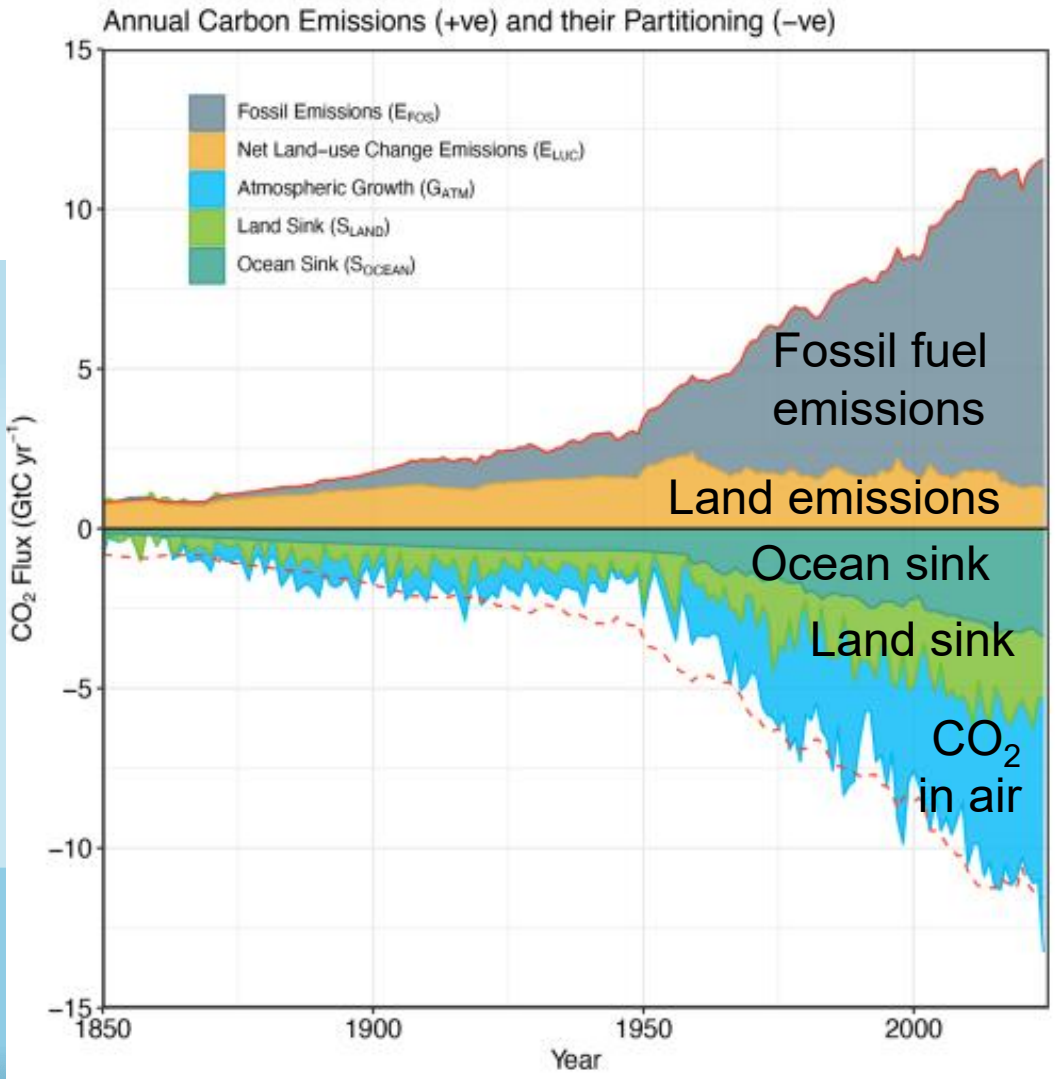
Pest control

Medicines

Nature and climate security

Land-based ecosystems and **oceans** absorb about half of the CO_2 emissions from fossil fuels and land use.

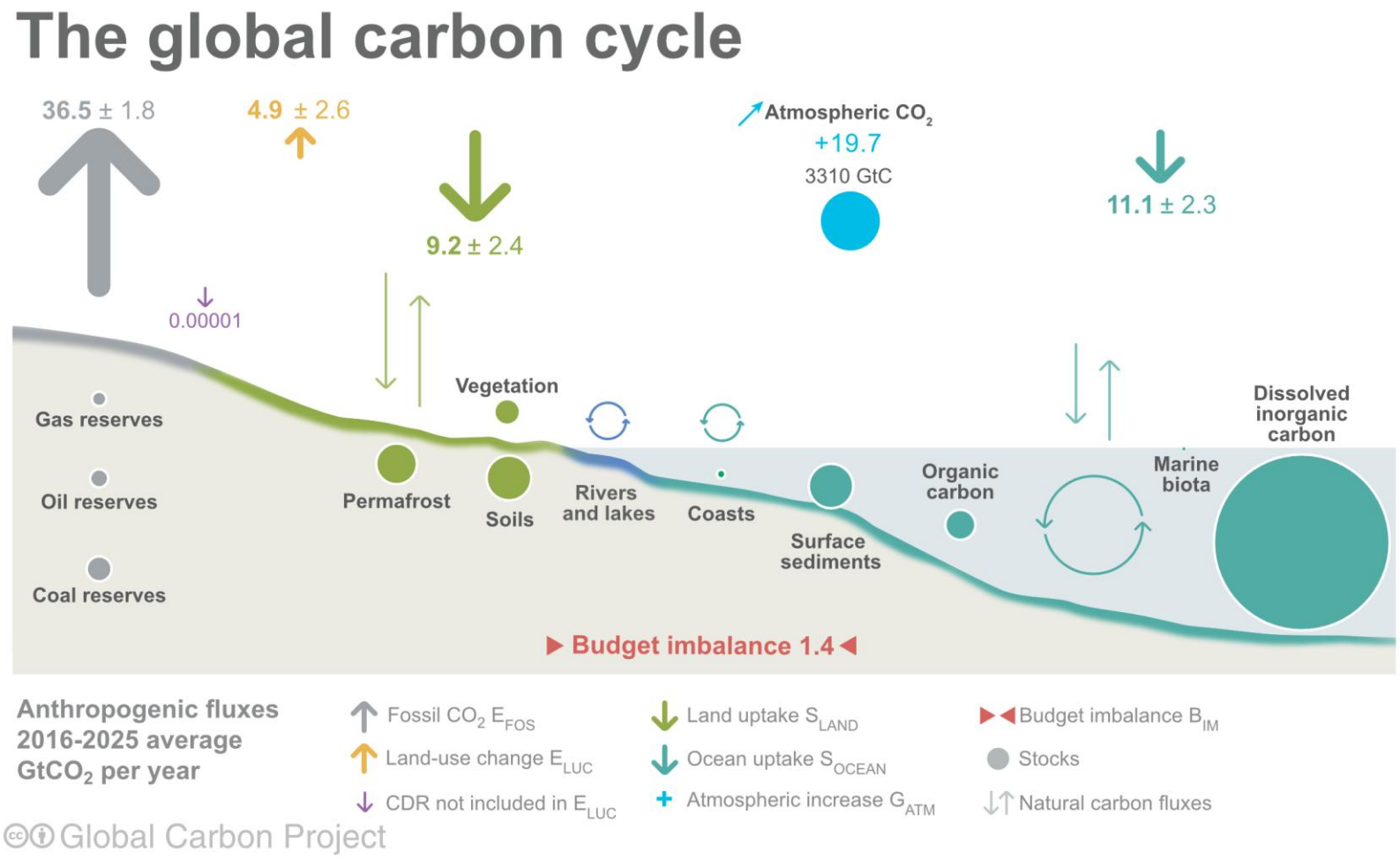




Friedlingstein et al 2025 Global Carbon Budget

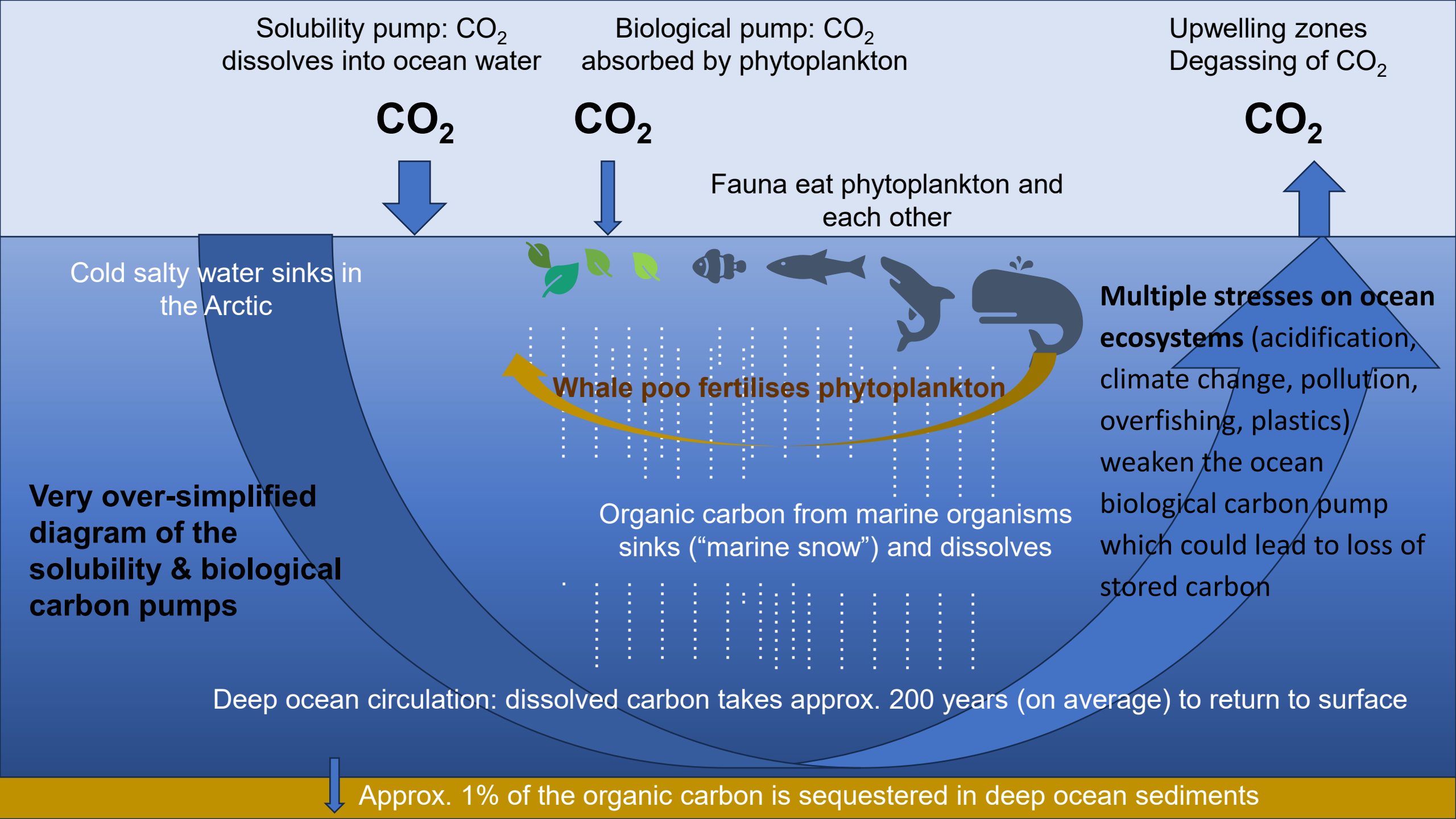
GLOBAL CARBON project

Perturbation of the global carbon cycle caused by anthropogenic activities, global annual average for the decade 2016–2025 ($GtCO_2$/yr)



"The world's oceans maintain climatically significant reservoirs of biogenic carbon that have been laid down by generations of biota spanning back 100s of years. It appears that during the past 10,000 yr, these reservoirs were in near equilibrium with fluxes in balancing fluxes out, … until about 75 yr ago. …Without healthy and fully functioning ecosystems to maintain the equilibrium, the oceans will become net emitters of biogenic carbon to the atmosphere." Visser, 2025.

CDR here refers to Carbon Dioxide Removal besides those associated with land-use that are accounted for in the Land-use change estimate. The budget imbalance is the difference between the estimated emissions and sinks. Source: NOAA-GML; Friedlingstein et al 2026; Global Carbon Project 2026


Solubility pump: CO_2 dissolves into ocean water
Biological pump: CO_2 absorbed by phytoplankton
Upwelling zones Degassing of CO_2
CO_2
CO_2
CO_2
Fauna eat phytoplankton and each other
Cold salty water sinks in the Arctic
Whale poo fertilises phytoplankton
Organic carbon from marine organisms sinks ("marine snow") and dissolves
Multiple stresses on ocean ecosystems (acidification, climate change, pollution, overfishing, plastics) weaken the ocean biological carbon pump which could lead to loss of stored carbon
Very over-simplified diagram of the solubility & biological carbon pumps
Deep ocean circulation: dissolved carbon takes approx. 200 years (on average) to return to surface
Approx. 1% of the organic carbon is sequestered in deep ocean sediments

Nature and water security

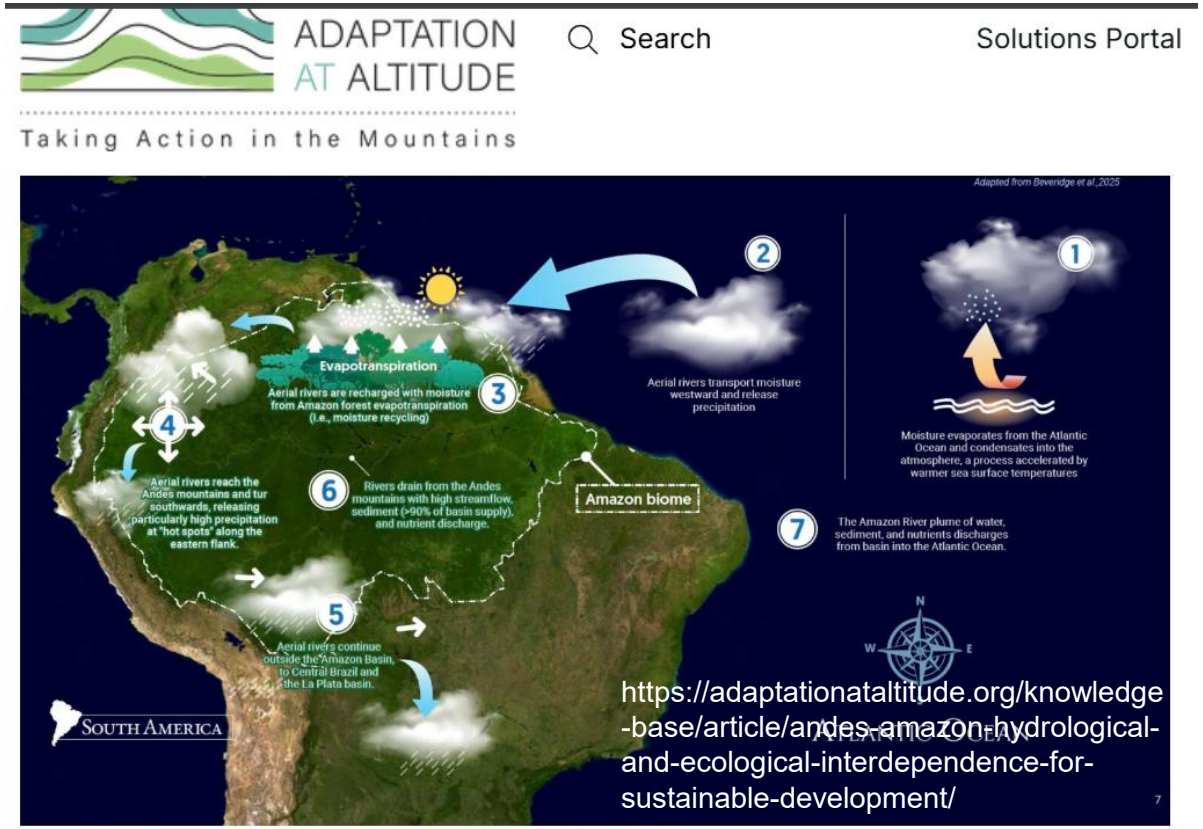
Rainforests generate rain that sustains the forest itself and surrounding regions.

About 35% of the world's rain falls on rainforests, and much of this is recycled into "aerial rivers" that travel thousands of miles.



Photo by David Clode on Unsplash

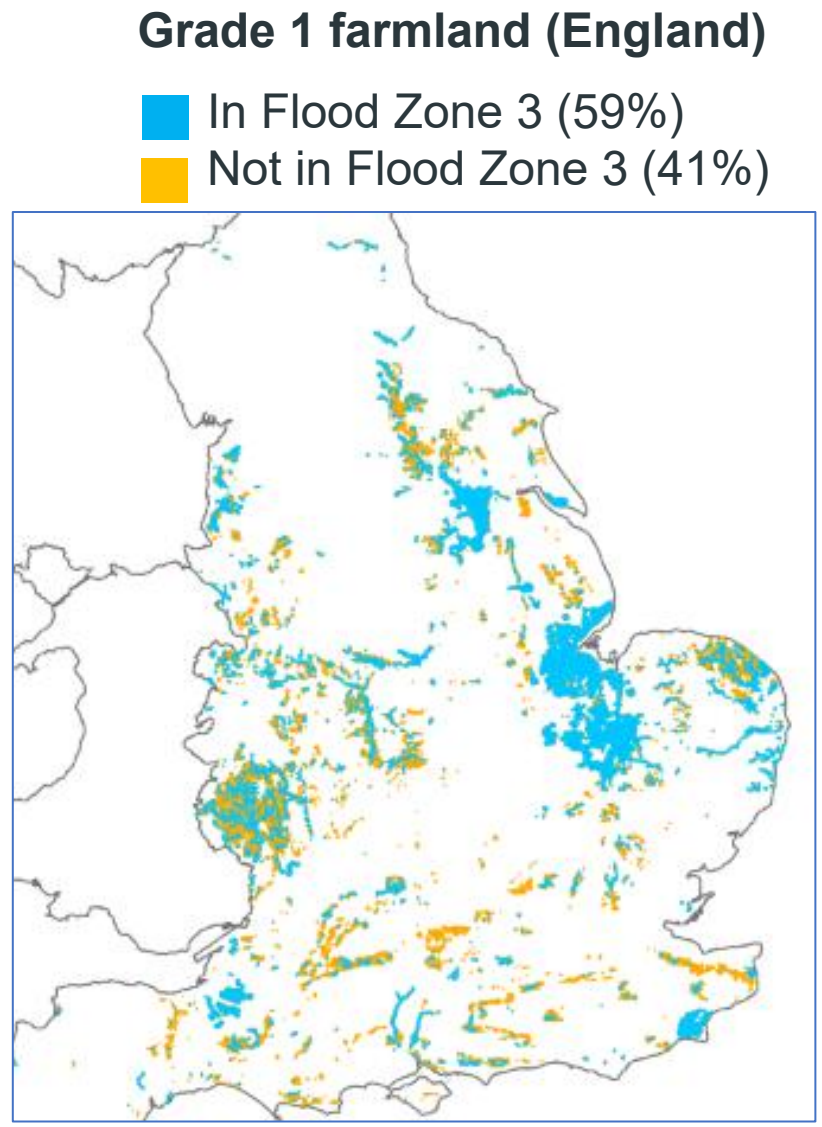
The Amazon forest sustains rainfall in the huge La Plata basin to the south, which produces most of South America's crops and hydropower.



"Aerial rivers" of the Amazon and the Andes (Source: Authors, p.7, adapted from *Beveridge et al., 2025*)

Nature and food security

- Declining occurrence of **wild pollinators** (-18%) & **pest predators** (-34%) in the UK 1970-2020.
- Pollinator loss threatens UK fruit, vegetable & oilseed crops worth £1.7 billion /y
  - ❖Possible increase in farmland bees due to government funding for 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.
- **Soil erosion** and loss of soil health from intensive farming
- 59% of Grade 1 farmland at risk of floods, and the Fens and much Grade 1-2 land also suffering water scarcity



Pollinators & pest predators need “weeds” & “scrub”

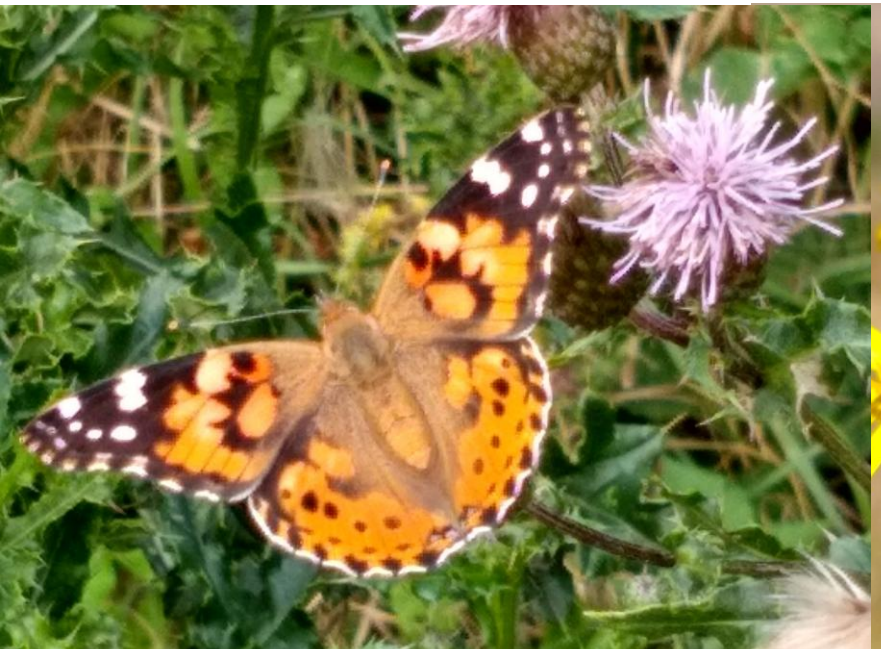
Top ten plants for pollinators (based on number of visits):

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.











Conflicts between food, energy and nature security

1. **Agriculture**: the main cause of deforestation globally (soy for livestock feed, coffee, cocoa, palm oil….)
2. **Overfishing** weakens the ocean biological carbon pump which could lead to loss of stored carbon
3. **Fossil fuel exploitation**: GHG emissions, air pollution, oil spills, habitat loss
4. **Clean energy infrastructure**
   - Damage to habitats from infrastructure
   - Wind turbines on peat or in bird migration routes
   - Solar farms on high grade farmland
   - Mining / deep sea mining for critical metals
5. **Bioenergy and BECCS**: Extraction of wood from old growth forests

Climate damage would obliterate any economic benefits of new North Sea fields, analysis shows

Exclusive: Economic harm of CO_2 pollution from Rosebank and Jackdaw forecast to far outweigh any boost to UK



ELSEVIER

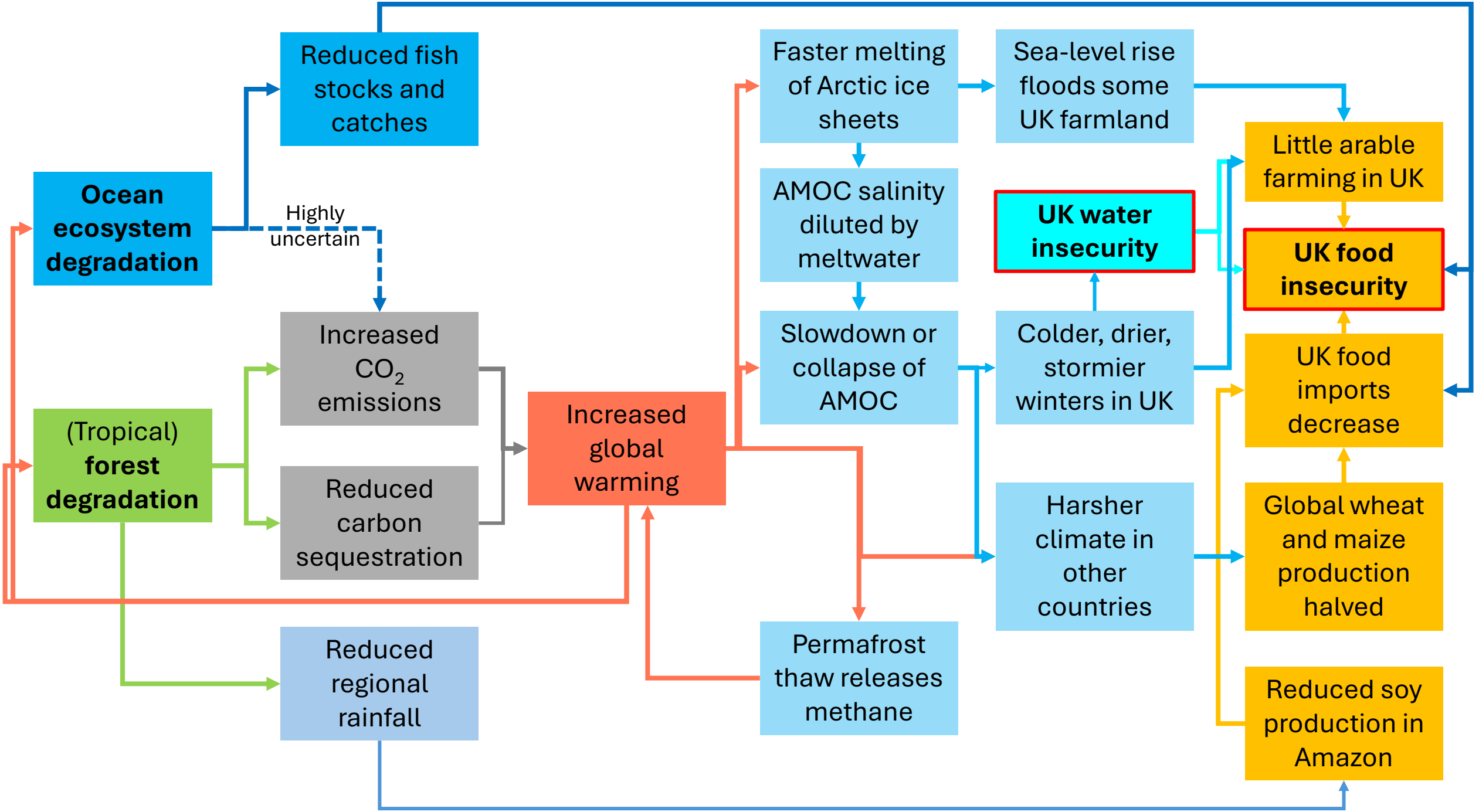
Energy Policy

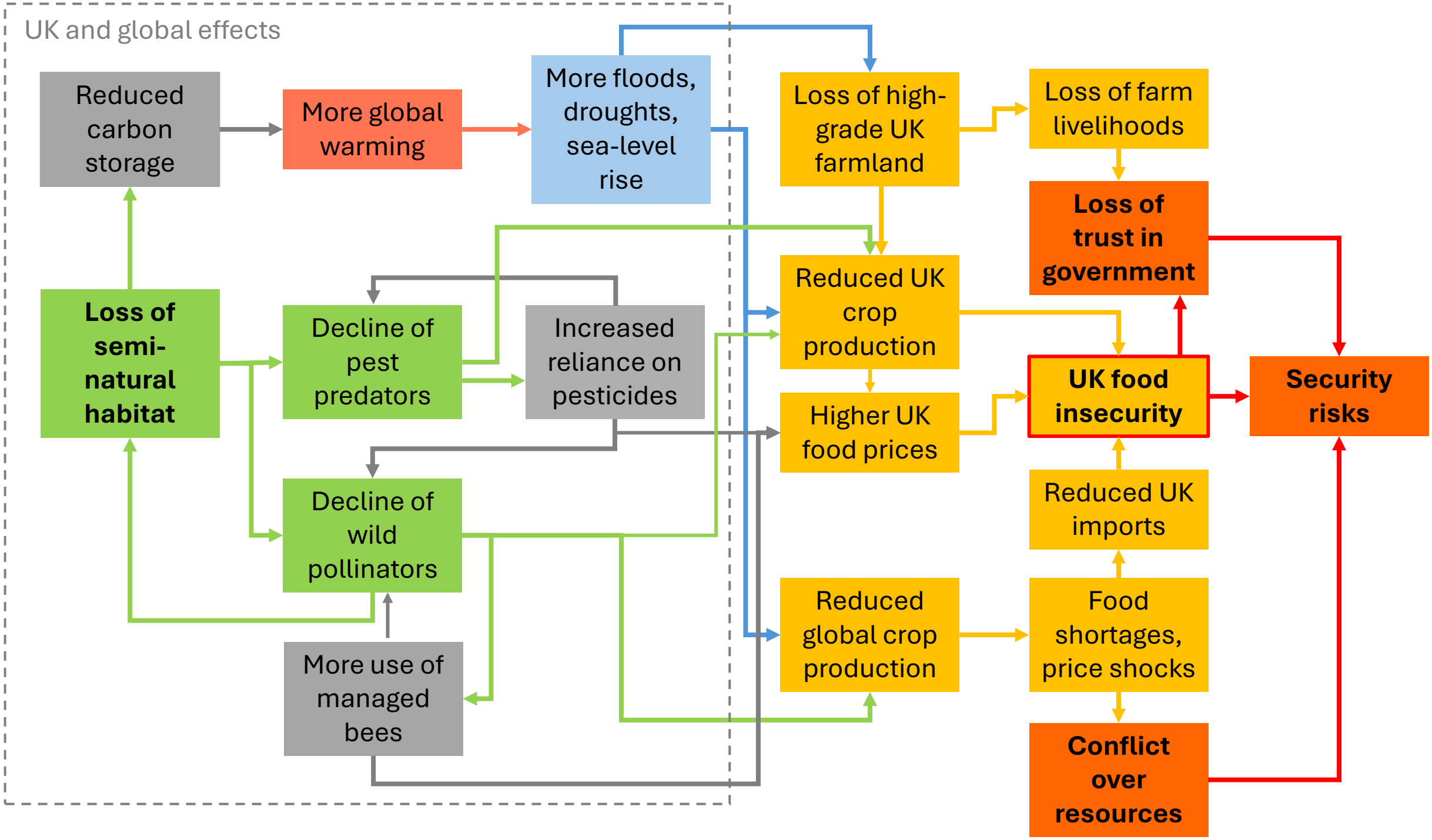
Volume 66, March 2014, Pages 585-591

ENERGY POLICY

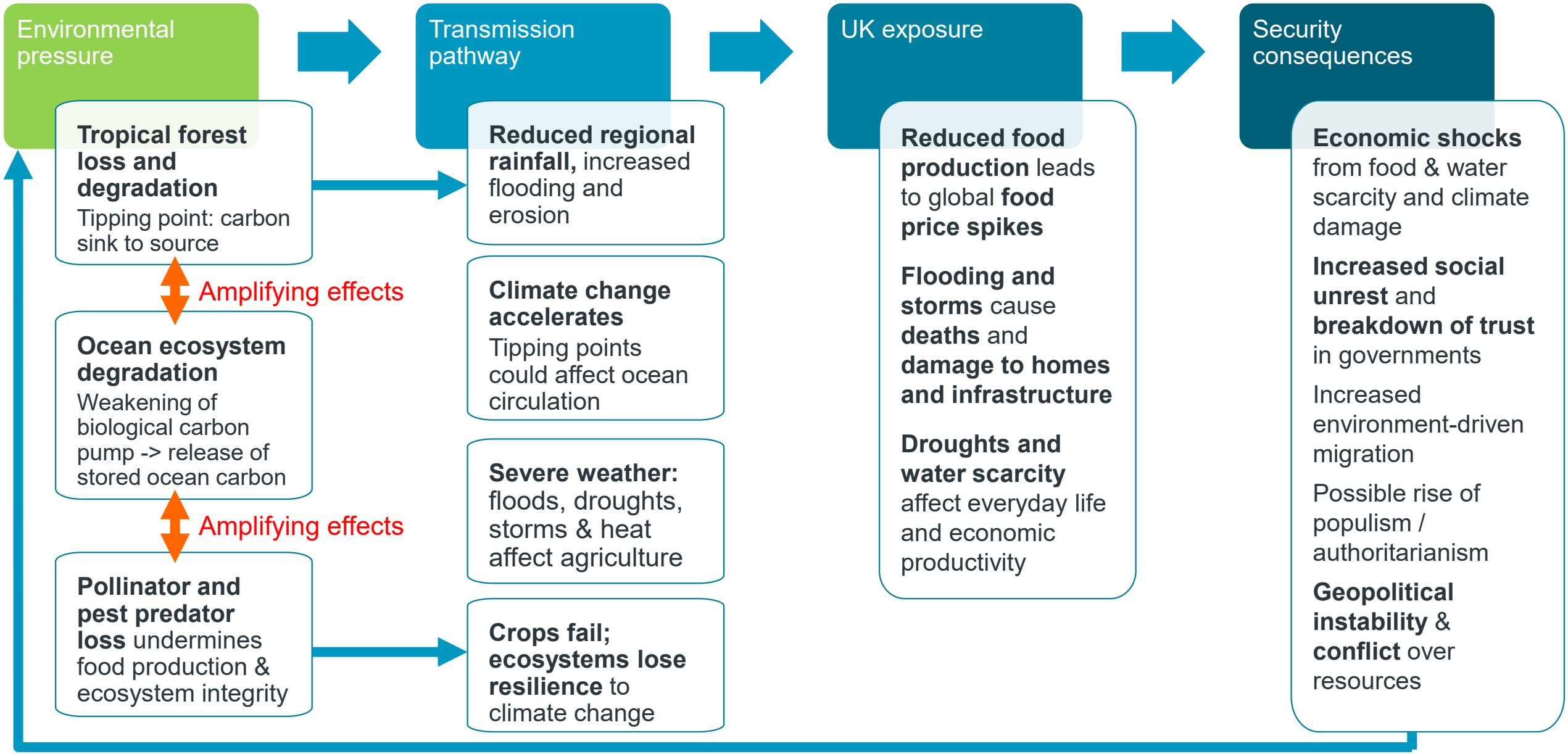
Wind farms on undegraded peatlands are unlikely to reduce future carbon emissions

Jo Smith, Dali Rani Nayak, Pete Smith


Reduced fish stocks and catches
Ocean ecosystem degradation
Highly uncertain
Increased CO_2 emissions
(Tropical) forest degradation
Reduced carbon sequestration
Increased global warming
Reduced regional rainfall
Faster melting of Arctic ice sheets
AMOC salinity diluted by meltwater
Slowdown or collapse of AMOC
Permafrost thaw releases methane
Sea-level rise floods some UK farmland
UK water insecurity
Colder, drier, stormier winters in UK
Harsher climate in other countries
Little arable farming in UK
UK food insecurity
UK food imports decrease
Global wheat and maize production halved
Reduced soy production in Amazon

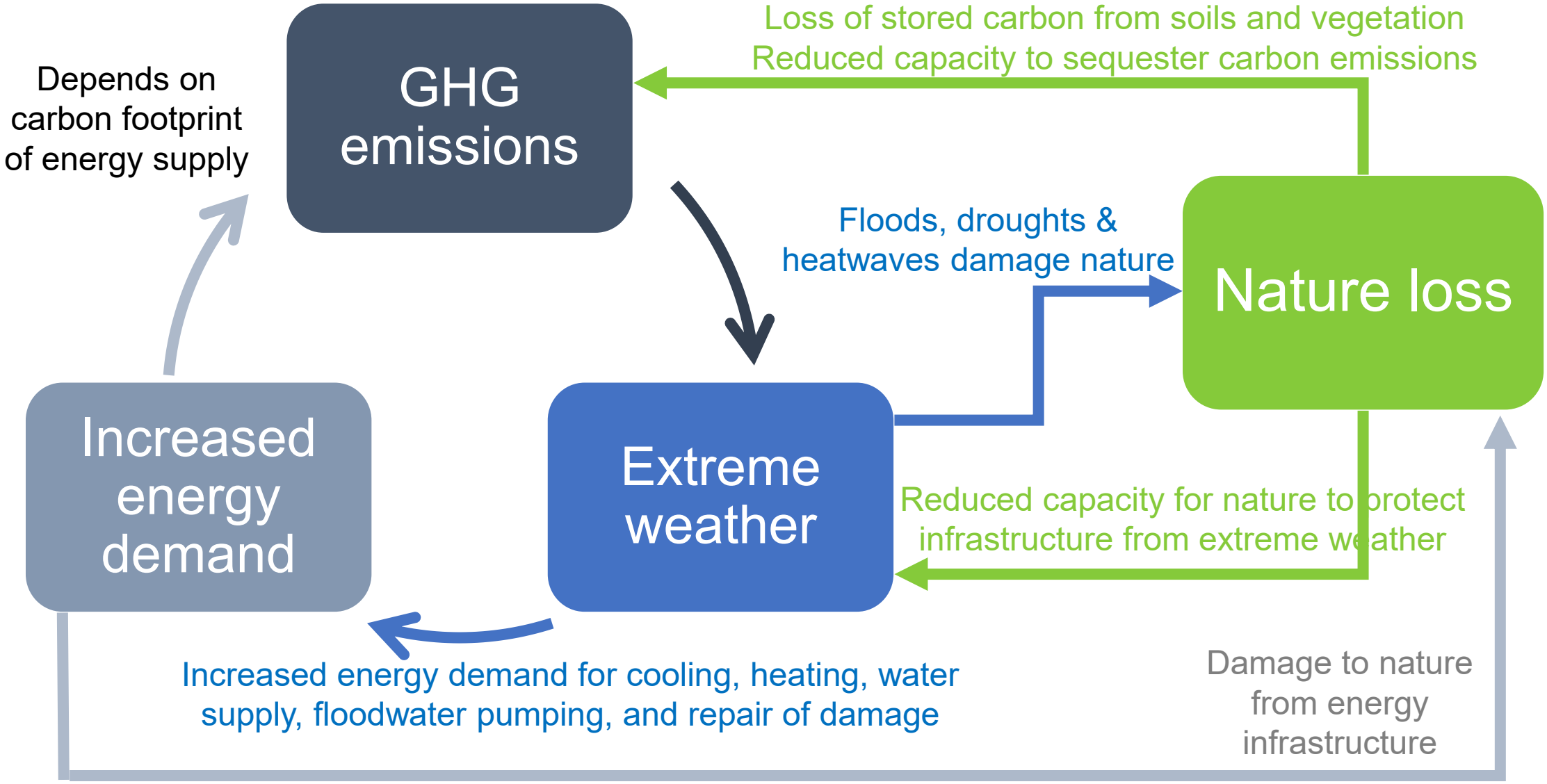

UK and global effects
Reduced carbon storage
More global warming
More floods, droughts, sea-level rise
Loss of high-grade UK farmland
Loss of farm livelihoods
Loss of trust in government
Loss of semi-natural habitat
Decline of pest predators
Increased reliance on pesticides
Reduced UK crop production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

Amplifying and cascading risks from degradation of critical natural infrastructure



Governance determines protection for nature and societal resilience to risk

Feedback loops between nature, climate and energy resilience



Interventions with multiple benefits

Increasing energy, food and water production using current methods can undermine resilience:

- **Increasing energy supply** can lead to habitat loss and degradation, water shortages and climate change
- **Intensive agriculture** drives biodiversity loss & GHG emissions
- **Desalination and water transport** use large amounts of energy

Low-impact supply: renewables, electrification, solar or membrane desalination, careful siting and design of energy infrastructure; stronger biomass standards; agroecology; nature protection.

Demand management: reduces adverse impacts & enhances resilience:



OpenClipart-Vectors from Pixabay

Energy, water & materials: efficiency, sufficiency, circularity



Food: more plant-based food, less waste

Interventions: Critical natural infrastructure for reducing exposure to risk

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			

Cascading benefits from Nature-based solutions for water security

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



Garron Plateau: Peatland restoration to reduce flooding and erosion



Eddleston Water: Natural flood management through river restoration

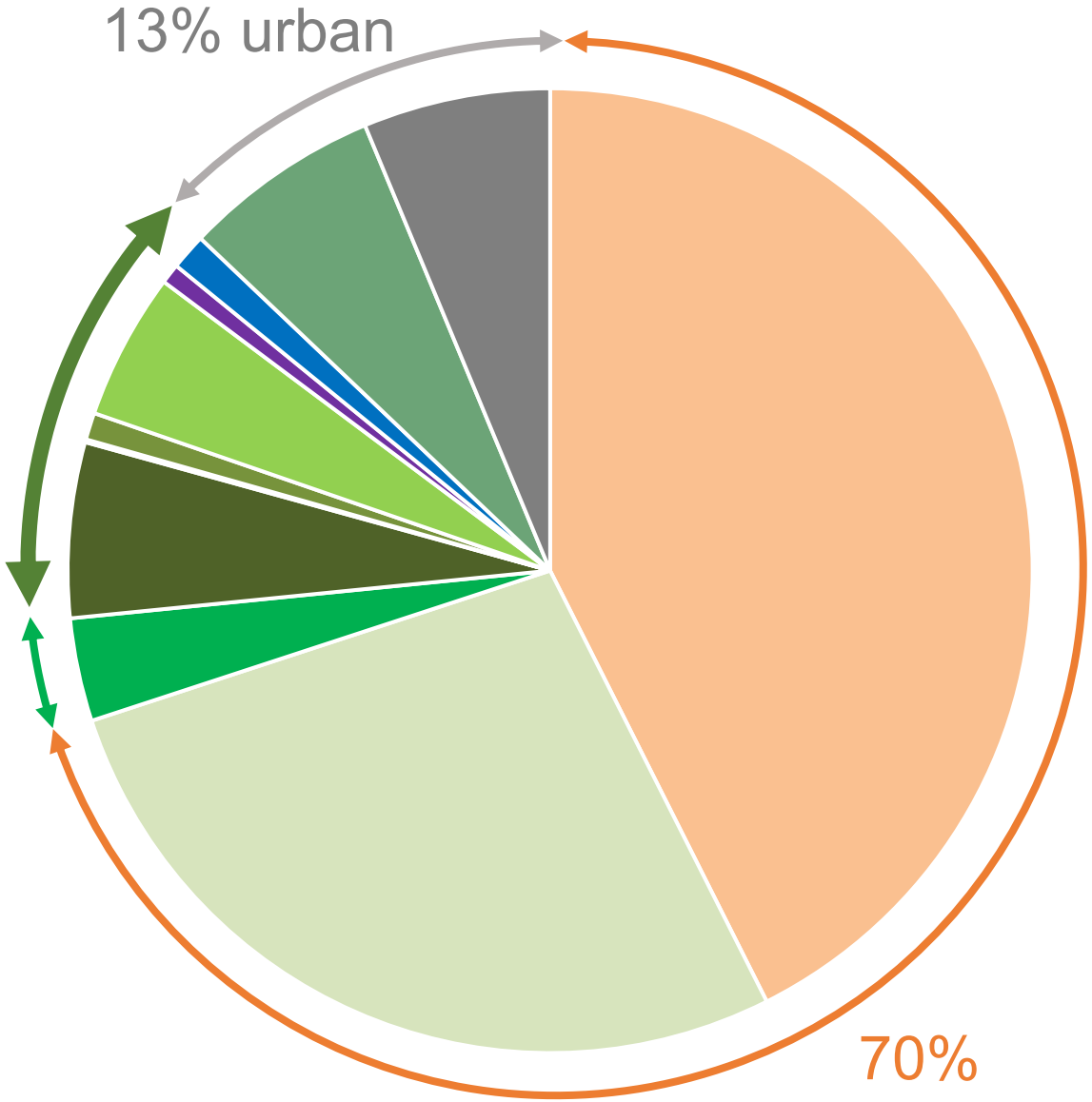


Sustainable drainage (SuDS): keeping stormwater out of combined sewers

Reducing pollution, protecting marine ecosystems



Protecting nature: How much is left in Oxfordshire?



- Arable (43%)
- Improved grassland (27%)
- Plantation woodland (3%)
- Semi-natural woodland (6%)
- Traditional orchards (0%)
- Wood pasture and parkland (1%)
- Semi-natural grassland (5%)
- Scrub, heath, wetland (1%)
- Water (1%)
- Green space & gardens (7%)
- Manmade (6%)

The State of Nature Report (2023)

Terrestrial and freshwater



The abundance of 753 terrestrial and freshwater species has on average fallen by 19% across the UK since 1970.

Within this average figure, 290 species have declined in abundance (38%) and 205 species have increased (27%).



The UK distributions of 4,979 invertebrate species have on average decreased by 13% since 1970.

Stronger declines were seen in some insect groups which provide key ecosystem functions such as pollination (average 18% decrease in species' control (34% decrease). By contrast, insect groups providing freshwater nutrient cycling initially declined before recovering to above the 1970 value (average 64% increase in species' distributions).



Since 1970, the distributions of 54% of flowering plant species and 59% of bryophytes (mosses and liverworts) have decreased across Great Britain.

By comparison, only 15% and 26% of flowering plants and bryophytes, respectively, have increased. In Northern Ireland, since 1970, 42% of flowering plant species and 62% of bryophytes have decreased in distribution, compared to 43% and 34%, respectively, that have increased.

Turtle dove, Ben Andrew (rspb-images.com); Forester moth, Mike Read (rspb-images.com); Heath Spotted-Orchid, Andy Hay (rspb-images.com); Ladybird Spider, Ian Hughes (rspb-images.com);



10,008 species were assessed using Red List criteria.

2% (151 species) are extinct in Great Britain and a further 16% (almost 1,500 species) are now threatened with extinction here. In Northern Ireland, 281 (12%) of 2,508 species assessed are threatened with extinction from the island of Ireland.

Marine



The abundance of 13 species of seabird has fallen by an average of 24% since 1986.

The situation is worse in Scotland, where the abundance of 11 seabird species has fallen by an average of 49% since 1986. These results pre-date the potentially major impact of the ongoing outbreak of

The Fingleton Review (2025)

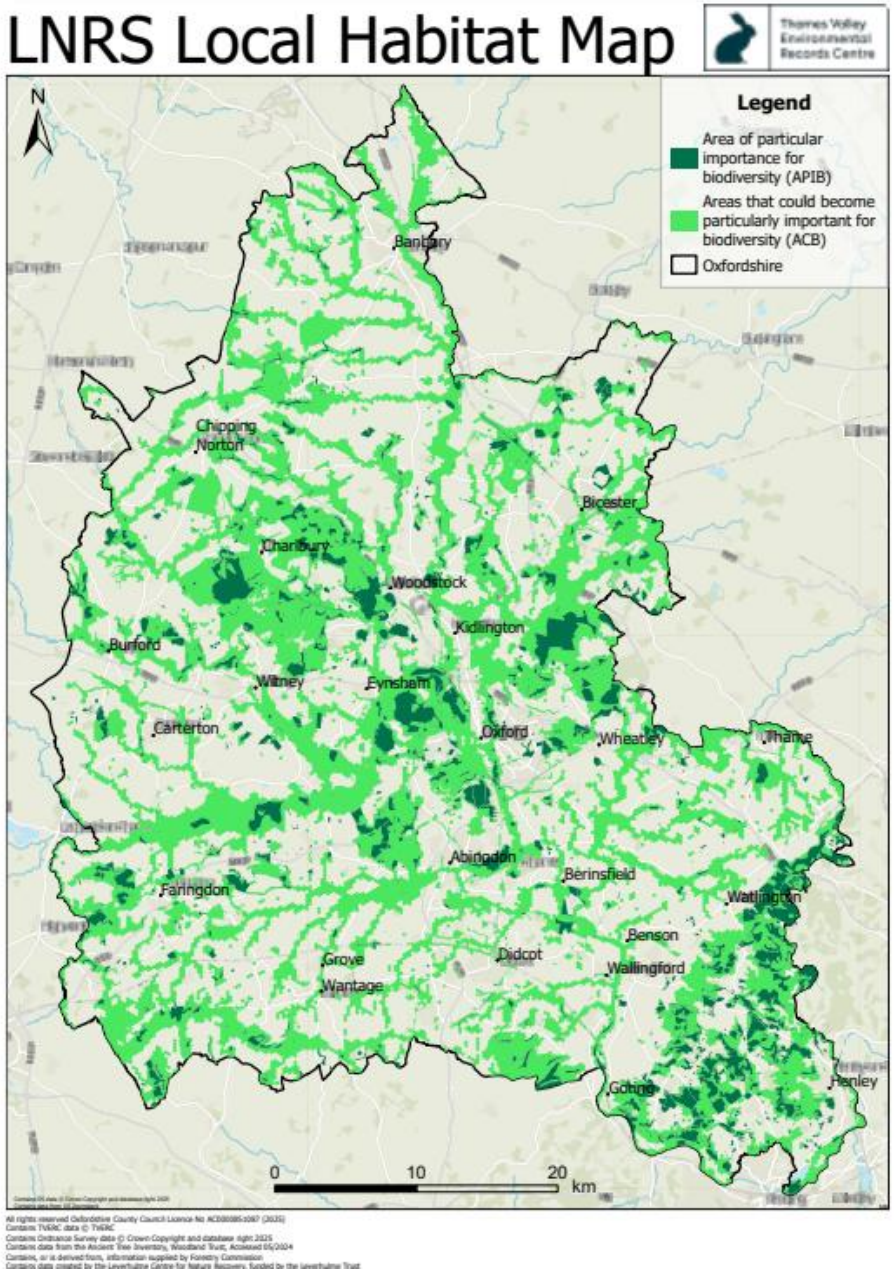
Economist John Fingleton said:

- A "radical reset" is needed to tackle "regulatory and planning barriers" he said are blocking new nuclear infrastructure.
- This includes changes to the Habitats Regulations to reduce "**risk aversion arising from an excessively precautionary approach**".

The Budget, October 2026:

- The government intends to "**extend the Fingleton Review's ethos …across other infrastructure sectors**"
- They will legislate to "reduce the risk that legal challenges slow infrastructure projects".

The First Oxfordshire Local Nature Recovery Strategy (Nov 2025)



- ✓ **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
- ✓ **Species-focused measures**
- ✓ **Designed in consultation with local communities**



Water vole



Dormouse



Little owl



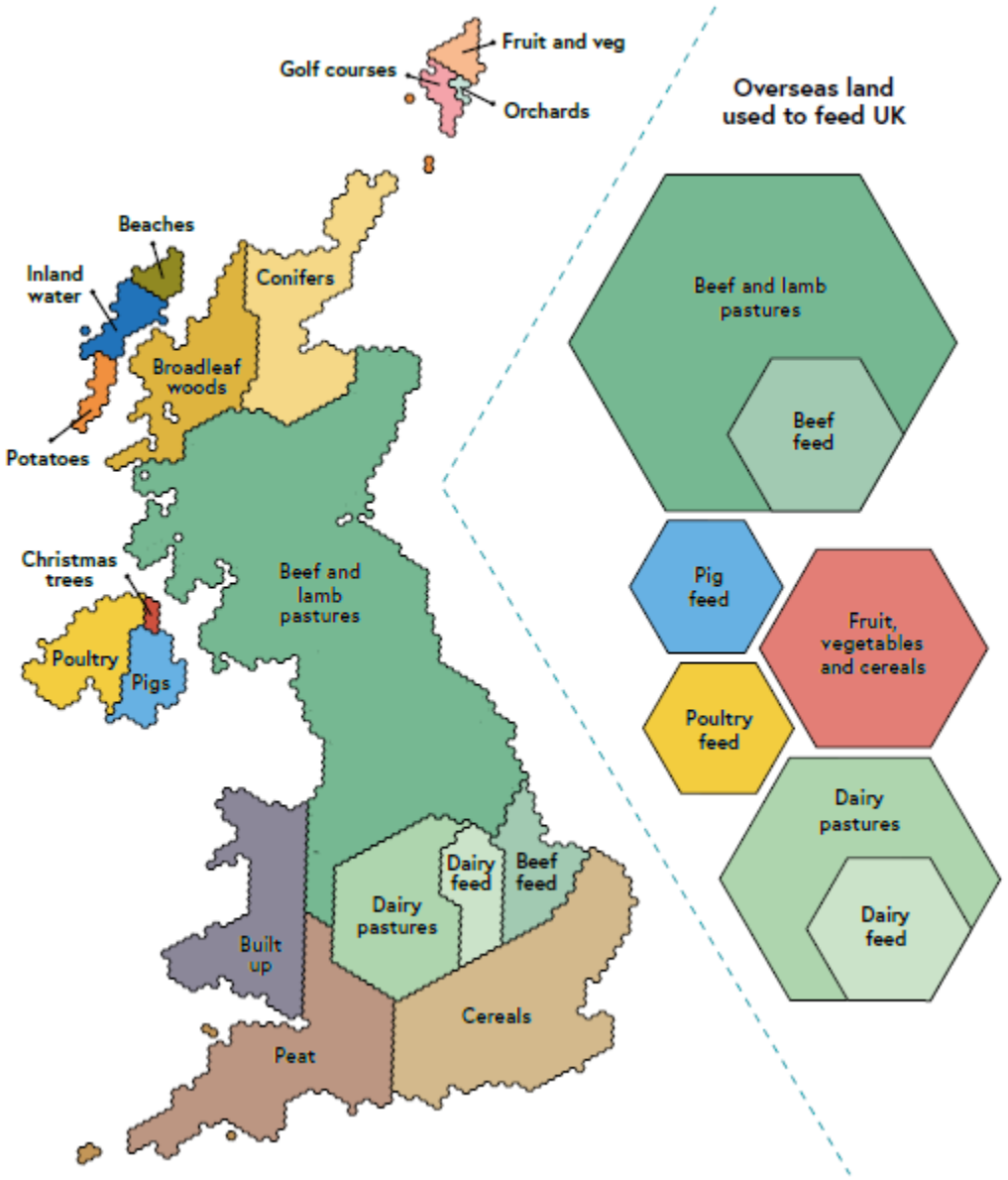
Adder



Meadow Clary



How do we make space for everything?



Source: National Food Strategy

Making space for nature, energy, food, water, housing and climate protection:

- Eat less meat and dairy
- Circular economy, less waste
- Protect high grade farmland
- Protect biodiverse areas
- Compact development that integrates green infrastructure
- Solar on rooftops
- Agroforestry
- Agri-voltaics
- …

BUT – socioeconomic and cultural issues must be addressed

Interventions: protect global critical natural infrastructure

Strengthen the UK's **global leadership** role by:

- ➢ Continuing strong policies to **phase out fossil fuels**
- ✓ Implementing **Glasgow declaration** on Forests and Land Use; Sponsoring **Tropical Forests Forever Facility**
- ➢ Banning bottom trawling in **Marine Protected Areas**
- ➢ Eliminating untreated **sewage discharges** into waterways
- ➢ Enforcing **catch quotas** in line with scientific advice
- ➢ Continuing to fund **nature protection programmes** such as OCEAN, the Blue Carbon Fund and the Darwin Initiative
- ➢ **Aligning climate and biodiversity policies** to protect nature from critical minerals extraction, unsustainable biomass use or risky geoengineering (seaweed sinking, iron fertilisation).





Interventions: UK critical natural infrastructure

Protect existing habitats. They store 3.6 Mt carbon (34 years of current UK GHG emissions).



Protect remaining Grade 1 and 2 farmland from development (including solar and wind)

Agrivoltaics reduce trade-offs.



Maintain and enhance **agri-environment schemes** for soil health, climate resilience, pollinators and pest predators



Interventions: local climate resilience

- **Nature-based solutions** including sustainable drainage systems and natural flood management can help to protect energy infrastructure from floods and erosion
- **Protect green space** and integrate **shade trees** and **green roofs** for cooling and flood protection
- **Biosolar roofs** can improve solar panel efficiency in hot weather

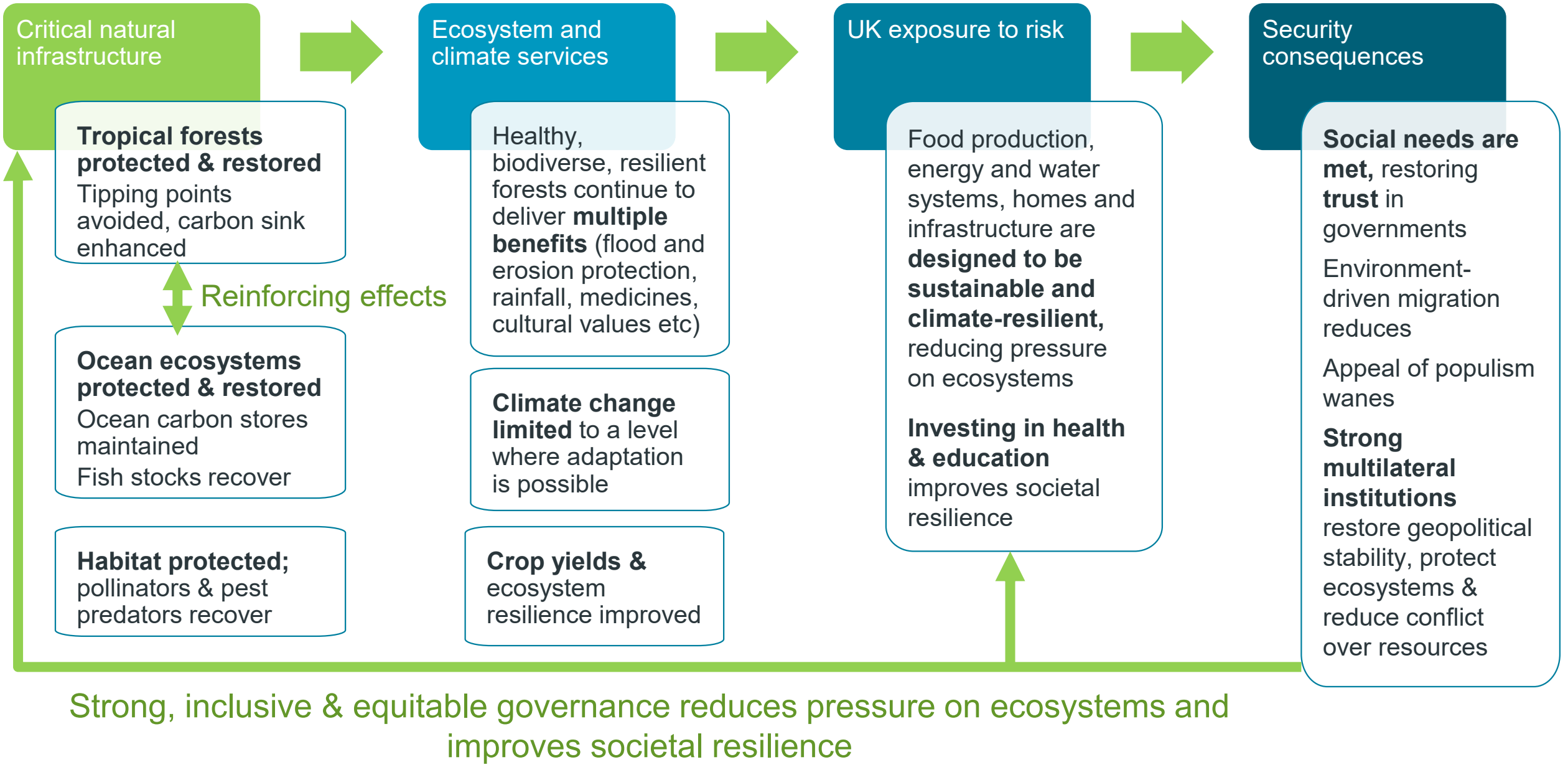

Sustainable Drainage System






Biosolar roof @Dusty Gedge

Protecting critical natural infrastructure: from cascading risks to cascading benefits



Data centres and critical minerals

Data centres threaten energy, water, climate and nature security.
140 proposed data centres (March 2026) would double demand for electricity in the UK (50 GW capacity cf UK peak demand 45 GW), exacerbate water scarcity, and bypass habitat protection regulations. Many of these applications are speculative, but proposals for adjacent gas-fired power stations are concerning. Ofgem (2026) Demand connections reform


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Europe must choose between AI and climate goals, data center lobby says

Tech sector says only carbon-emitting gas plants are reliable enough today to power the EU's AI goals.

Critical minerals for clean energy is driving increased mining, including seabed mining that would damage sensitive habitats. A circular economy approach to reuse and recycle energy infrastructure can increase resilience and reduce impacts on nature.

Recommendations

- **Recognise** energy, food, water, health, climate and critical natural infrastructure as interconnected national security priorities.
- **Shift from siloed policymaking** to coordinated, long-term cross-departmental governance with statutory targets and regulations for environmental security
- **Establish a new body to facilitate demand management** and make sustainable choices the affordable default, with a major public awareness and education campaign
- **Combine short-term pressure alleviation (e.g. price caps) with long-term system reform** (e.g. fossil fuel decoupling, circular economy, market reform, energy efficiency and sufficiency programmes, targeted poverty alleviation linked to prices)
- **Align climate, food and biodiversity policies** to protect nature (critical mineral recycling, siting of renewables, sustainable biomass, limits on geoengineering) and support nature-based solutions (agroecology, natural flood management, green infrastructure)
- **Data centres** must be compatible with carbon, water and nature targets

Thank you

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

<u>Evidence reports:</u>

- The role of critical natural infrastructure in supporting national security
- Managing demand: energy security, food security and UK national security
- Climate risks and opportunities for maritime shipping and UK trade
- Environment-driven mobilities and UK national security
- Weaponisation of nature
- Environment and social resilience

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