HM Government

Global biodiversity loss, ecosystem collapse and national security

A national security assessment

Key judgements

	Analytical Confidence Rating (AnCR)
1. **Global ecosystem degradation and collapse threaten UK national security and prosperity.** The world is already experiencing impacts including crop failures, intensified natural disasters and infectious disease outbreaks. Threats will increase with degradation and intensify with collapse. Without major intervention to reverse the current trend, this is highly likely to continue to 2050 and beyond.	**High**
2. **Cascading risks of ecosystem degradation are likely to include geopolitical instability, economic insecurity, conflict, migration and increased inter-state competition for resources.**	**Moderate**
3. **Critical ecosystems that support major global food production areas and impact global climate, water and weather cycles are the most important for UK national security.** Severe degradation or collapse of these would highly likely result in water insecurity, severely reduced crop yields, a global reduction in arable land, fisheries collapse, changes to global weather patterns, release of trapped carbon exacerbating climate change, novel zoonotic diseases and loss of pharmaceutical resources. The Amazon rainforest, Congo rainforest, boreal forests, the Himalayas and South East Asia's coral reefs and mangroves are particularly significant for the UK.	**High**
4. **Ecosystem degradation is occurring across all regions. Every critical ecosystem is on a pathway to collapse** (irreversible loss of function beyond repair).	**High**
5. **There is a realistic possibility that some ecosystems (such as coral reefs in South East Asia and boreal forests) start to collapse from 2030, and others (rainforests and mangroves) start to collapse from 2050.**	**Low**
6. **All countries are exposed to the risks of ecosystem collapse within and beyond their borders.** Some will be exposed sooner than others and are likely to act to secure their interests, particularly water and food security.	**Moderate**
7. **Without significant increases in UK food system and supply chain resilience, it is unlikely the UK would be able to maintain food security if ecosystem collapse drives geopolitical competition for food.** The UK relies on imports for a proportion of both food and fertiliser and cannot currently produce enough food to feed its population based on current diets. Countries best placed to adapt are those that invest in ecosystem protection and restoration, and resilient and efficient food systems.	**Moderate**

These analytical confidence ratings and probabilistic judgements are explained on the next page.

National security assessments

This national security assessment draws on a broad range of sources, including both scientific literature and expert judgement. It is not a scientific report. It assesses a reasonable worst case scenario and applies the uncertainty frameworks used in intelligence assessments. Its aim is to support UK national security planning by identifying risks to the UK from global biodiversity loss and ecosystem collapse.

THIS ASSESSMENT ANSWERS:

1. What are the most significant implications of global biodiversity loss and ecosystem collapse for UK national security?
2. Which ecosystems are more critical for UK national security?
3. What would be the impact on UK national security from the collapse of individual critical ecosystems?

ANALYTICAL CONFIDENCE RATINGS

High: we have high confidence in our assessment of global ecosystem degradation trends, and in their biological and physical impacts. We have high confidence that every critical ecosystem is degrading. These trends are based on a large scientific evidence base that is often revised to give further detail on trends.

Moderate: we have moderate confidence in assessing the human costs from ecosystem degradation and collapse, but lower confidence in assessing the security risks. The resilience of human systems to ecosystem degradation is moderately uncertain and the wider geopolitical context out to 2030 and 2050 is highly uncertain.

Low: we have low confidence in our assessment of the exact timing and pathways of critical ecosystem collapse, given the multiple drivers involved as well as the complex feedback loops and lack of data in some areas (particularly the Congo).

DEFINITIONS (full glossary at Annex A)

Ecosystem degradation: a long term reduction in an ecosystem's structure, functionality, or capacity to provide benefits to people.

Ecosystem collapse: refers to a critical threshold beyond which an ecosystem is potentially irreversibly changed and can no longer maintain essential structure or function.

How we explain uncertainty in this assessment

This assessment applies the uncertainty frameworks used in intelligence assessments. Intelligence assessments support decision-making in environments where information tends to be incomplete, conflicting or unreliable and therefore subject to different interpretations. Analysis seeks to resolve uncertainty but cannot fully eliminate it. We will always communicate what doubt remains in our key analytical judgements upon completion of our analysis. This is to highlight potential impact on the assessment and resulting decisions.

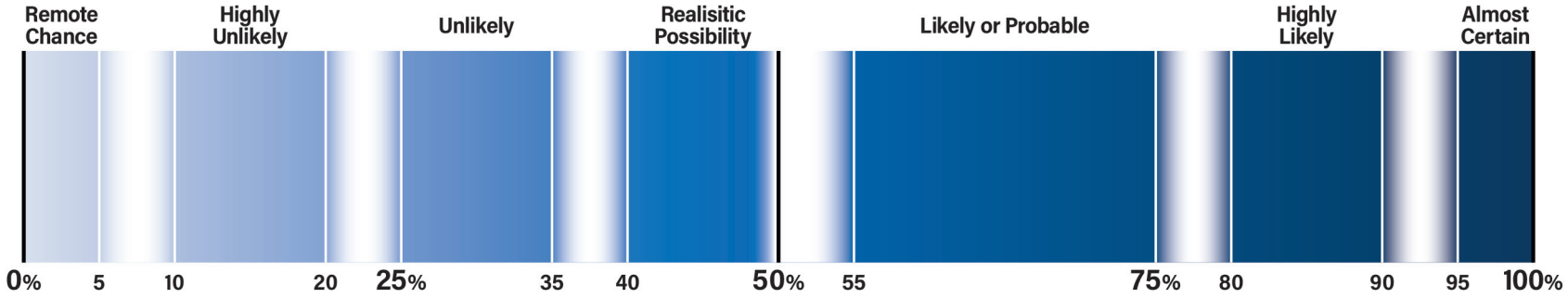
We use two frameworks to describe different but related aspects of uncertainty in this intelligence assessment:

(i) Probability Yardstick - We use this standard set of language in probabilistic judgements to describe our assessed likelihood that a statement is true or that an event will occur, is occurring or has occurred; and

(ii) Analytical Confidence Ratings (AnCRs) and statements - We use these ratings, which are based on a standard evaluation criteria, to make clear the strengths and limitations of the key judgements made. Particularly in the context of forward-looking judgements, analytical confidence also explains the susceptibility of the judgement to change. Confidence ratings and statements can be used by the readers of an assessment to evaluate how much weight they should put on assessments when making decisions. They flag up key gaps in our knowledge, note factors beyond our control and identify where we can strengthen assessments to better inform future decision-making.

Clearly communicating uncertainty allows customers to take it into account when making decisions based on our assessment.

PHIA Probability Yardstick



For further information on how we explain uncertainty in intelligence assessment see **this link.**

Biodiversity loss is a global threat

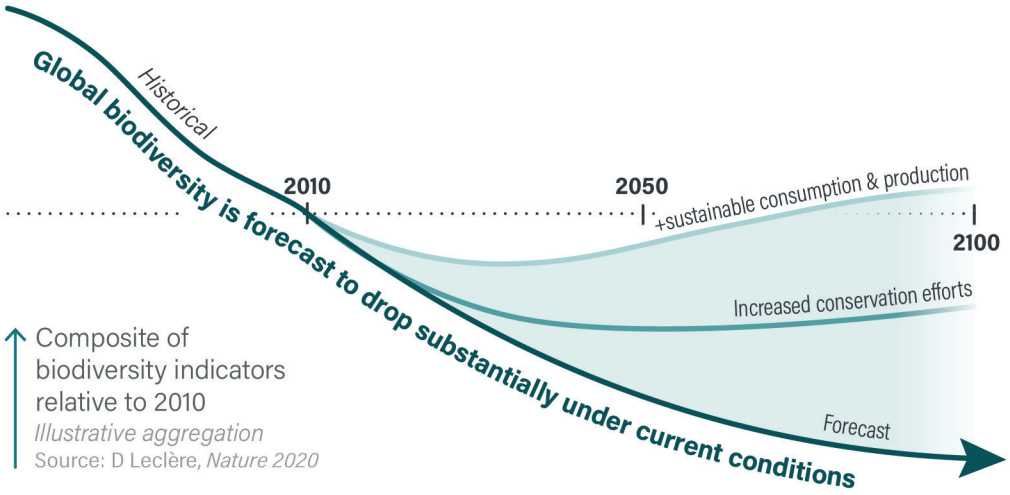
The world is already experiencing the impacts of biodiversity loss, including crop failures, intensified natural disasters and infectious disease outbreaks.[1,2,3]

Ecosystem degradation is occurring across all regions and ecosystems. The average size of monitored wildlife populations declined by 73% between 1970-2020. Populations of vertebrate species have declined by an average of 68% since 1970. Freshwater ecosystem species populations have shown the largest losses, falling 84% in the same period.[4]

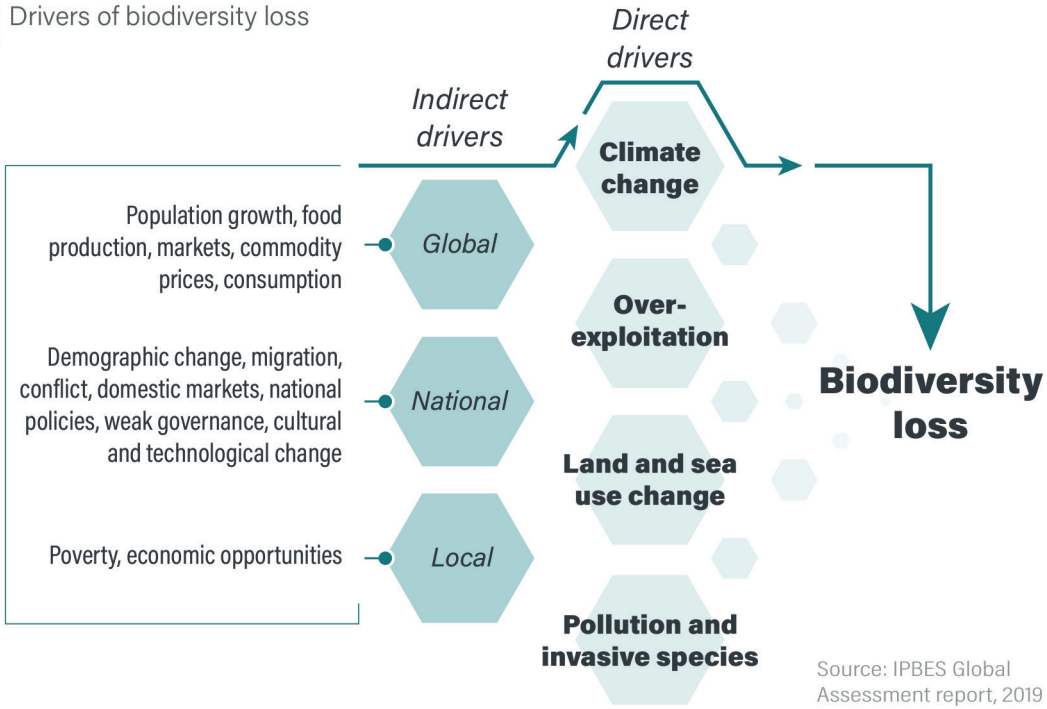
The rate of extinction is tens to hundreds of times higher than the average over the past 10 million years. It suggests that a sixth mass extinction may be underway.[2, 5]

With current trends, global ecosystem degradation is highly likely to continue to 2050 and beyond. There is a high degree of uncertainty around the timing and pathways of ecosystem degradation, given the number and complexity of the drivers involved.

Food production is the most significant cause of terrestrial biodiversity loss.[6, 7] As the global population grows, reaching 9.7 billion by 2050,[8] the impact of food production on natural systems will intensify and it will become even more challenging to produce sufficient food sustainably.



Drivers of biodiversity loss



Source: IPBES Global Assessment report, 2019

Halting and reversing biodiversity loss

Some of the solutions to biodiversity loss, such as forest protection and restoration, can only be enacted locally. Parties to the UN Convention on Biological Diversity, including the UK, agreed the Kunming-Montreal Global Biodiversity Framework in 2022, a landmark agreement to 'halt and reverse biodiversity loss by 2030.' Its targets, if met, would change the current trajectory and include:

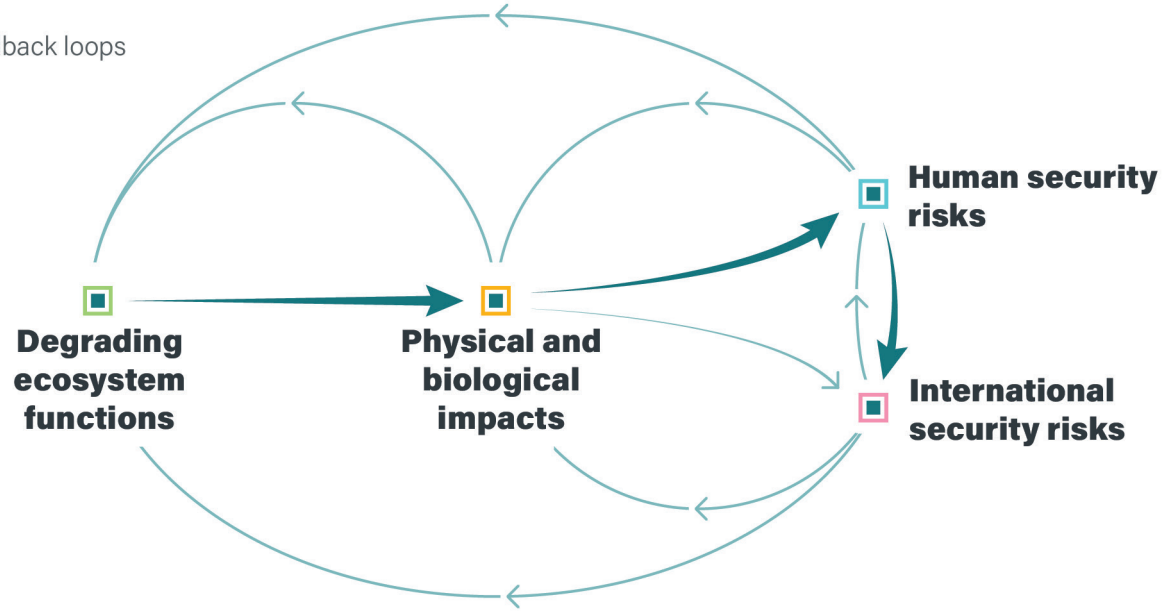
- Protecting 30% of global land and ocean by 2030;
- 30% of global nature to be under restoration by 2030;
- Mobilising finance to close the funding gap of $700bn;
- Reducing risks from pesticide usage by 50% by 2050;
- Eliminating or reforming harmful subsidies by $500bn per year.

It would also be necessary to meet the Paris climate agreement target of limiting warming to 1.5°C.

Biodiversity loss impacts national security

Nature is a foundation of national security. Biodiversity loss is putting at risk the ecosystem services on which human societies depend, including water, food, clean air and critical resources. The impacts will range from crop failures, intensified natural disasters and infectious disease outbreaks to conflict within and between states, political instability, and erosion of global economic prosperity. Increasingly scarce natural resources will become the focus of greater competition between state and non-state actors, exacerbating existing conflicts, starting new ones and threatening global security and prosperity.

Biodiversity loss impacts and feedback loops



Degrading ecosystem functions

- Water regulation and cycling
- Soil formation
- Oxygen production
- Pollination
- Disease control
- Air quality
- Erosion control
- Food production
- Carbon storage

Physical and biological impacts

- Crop failure
- Fisheries loss
- Water and air pollution
- Water scarcity
- Novel diseases
- Floods, storms, landslides
- Changes to global weather patterns
- Loss of genetic diversity
- Global temperature rise

Human security risks

- Food shortages, inflation, famine
- Water insecurity
- Health risks
- Supply chain disruption
- Livelihood loss, poverty
- Lost of pharmaceutical opportunities
- Elite capture of resources
- Pandemic risk

International security risks

- Migration
- Extremism, terrorism
- Serious Organised Crime
- Political polarisation and instability
- Economic insecurity
- Interstate conflict, civil wars

Case study: failing coffee harvests driving migration from Central America to the USA.

Food insecurity and lack of economic opportunities are the main drivers of migration in Central America, ahead of corruption, poor governance and serious organised crime. Between 2012-14, the coffee leaf rust disease caused many Central American coffee farmers to have zero production, exacerbating existing economic insecurity and displacing 373,000 people across Central America according to some estimates. Since then, highly erratic weather patterns have led to increased drought and flooding, resulting in a loss in 60% of the Central American coffee harvest in 2018. The low-income groups whose livelihoods rely on coffee production, have been driven to migrate, both internally and to the USA.

Source: 'The Security Threat That Binds Us', Council for Strategic Risk, 2021

Cascading risks result when the impacts of biodiversity loss escalate through a system of connections. For example, degradation of large areas of tropical rainforests will reduce water availability and food production in a region much wider than the forest itself. This will increase pressure on remaining arable land, which people, companies and countries will compete for. Increasing competition for scarce food production will contribute to political instability and interstate conflict.

Critical ecosystems are at risk of collapsing (1)

If current rates of biodiversity loss continue, every critical ecosystem is on a pathway to collapse.

An ecosystem collapses when it passes beyond a critical threshold or tipping point, after which it can no longer maintain essential functions or structure, leading to extensive shifts to its size and composition. The ecosystem transitions irreversibly from one stable state to another. For instance, the Amazon basin collapse would see it shifting to a drier savannah state.

Collapse impairs an ecosystem's ability to provide vital services including clean water, food production, and climate regulation. This could accelerate climate change and biodiversity loss and have catastrophic implications, including the collapse of major food sources and fundamental changes to global weather patterns and the water cycle.

As biodiversity loss and degradation continue, impacts become more severe and the likelihood of ecosystems collapsing increases. It is likely that ecosystem collapses would happen concurrently given their shared drivers and feedback loops.

There is a high degree of uncertainty around the timing and pathways of ecosystem collapse. The drivers of ecosystem degradation are approaching the known thresholds for collapse - for example, the Amazon is likely to collapse at 20-25% deforestation when combined with temperature rises and forest fires; it is currently at 17%. [9-13] But the thresholds for collapse could be higher or lower than the science has been able to identify: we could be closer to, or further away from, the thresholds than we think; and there could be additional thresholds that we do not know about yet. There is a realistic possibility that trends to date mean we have unknowingly crossed thresholds already and irreversible collapse of some ecosystems is inevitable (for example coral reefs), though we may not see the impacts for several years.

There is a realistic possibility some ecosystems start to collapse by 2030 or sooner, as a result of biodiversity loss from land use change, pollution, climate change and other drivers. There is a realistic possibility that coral reefs in SE Asia and boreal forests will start to collapse from 2030, and rainforests and mangroves from 2050.

Preventing ecological collapse would require the reduction of human impacts, alongside restoration of ecosystems. Restoration of some ecosystems (tropical forests) is more feasible than others (coral reefs, Himalayas).

Case study: protecting and restoring ecosystems improves food system and societal resilience to shocks.

In Malawi, over 20 million trees have been planted and 42,000 hectares of degraded land rehabilitated. This has supported over 500,000 local residents with improved access to water, diversified food production and income sources. The number of participants depending on humanitarian aid has declined by 60%.

Source: Restoring ecosystems to boost resilience to climate shocks in Malawi, World Food Programme, 2023

Planetary boundaries are the safe limits identified by scientists for human pressure on nine Earth system processes crucial for maintaining a stable planet. As of 2023, six boundaries have been crossed:

(1) biosphere integrity (including biodiversity loss);
(2) climate change;
(3) land use change;
(4) freshwater change;
(5) nutrient flows (nitrogen and phosphorus); and
(6) novel entities (chemical and plastic pollution).

The three remaining boundaries are:

(7) stratospheric ozone depletion;
(8) atmospheric aerosol loading; and
(9) ocean acidification.

Source: Stockholm Resilience Centre, 2023

Since the drafting of this report, a new version of this research has been published.

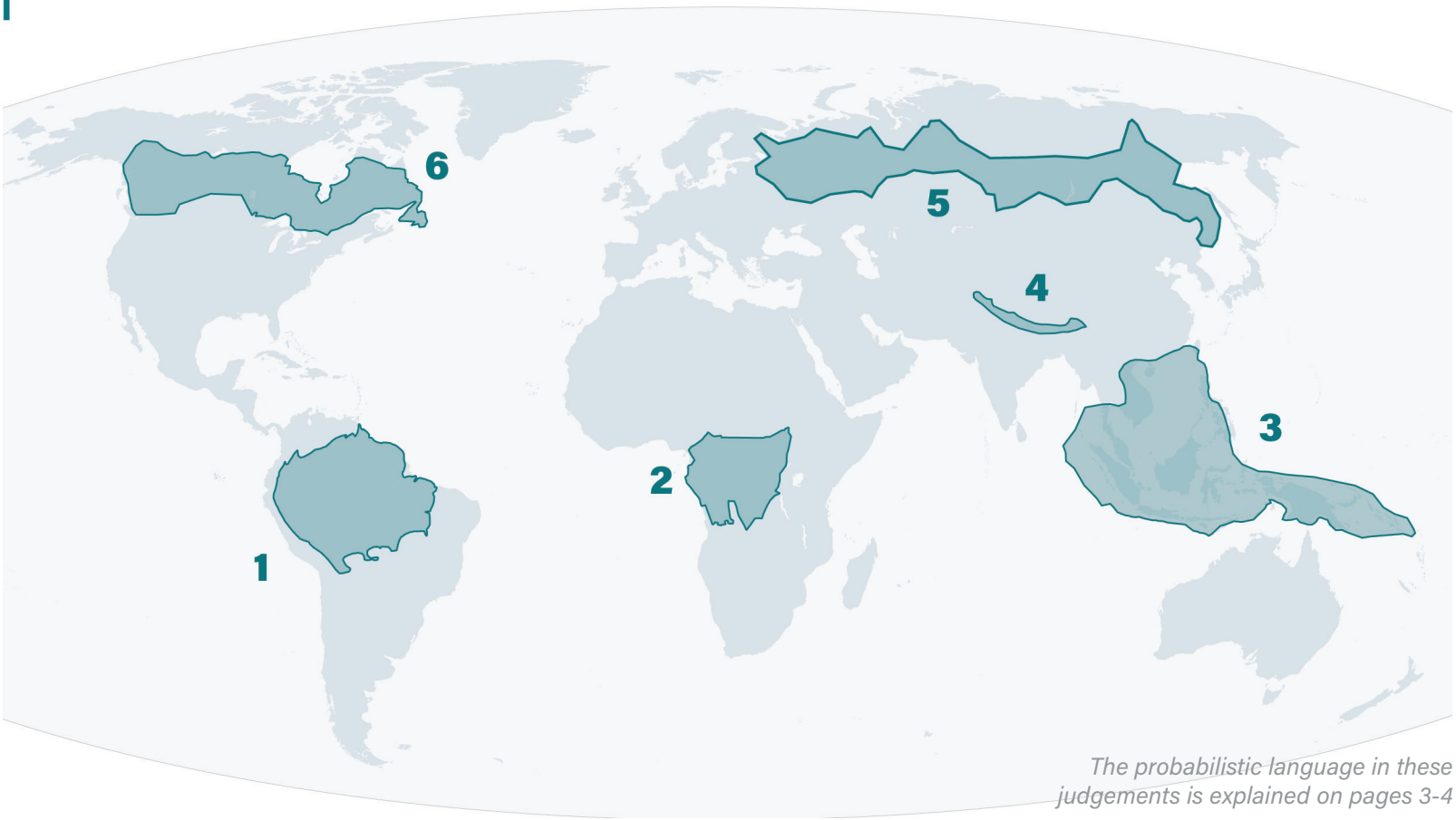
Critical ecosystems are at risk of collapsing (2)

Six ecosystem regions are critical for UK national security given the likelihood and impact of their collapse. Severe degradation or collapse would drive displacement of millions, change global weather patterns, increase global food and water scarcity, and drive geopolitical competition for remaining resources. Although many other global ecosystems are important, these six meet at least three of the following ecological features.

Ecological features

- Scale of impact
- Speed of collapse
- Intactness
- Degradation to quality of life
- Irrecoverable carbon

6 critical ecosystem regions



The probabilistic language in these judgements is explained on pages 3-4

Ecosystem regions

1	**Amazon rainforest** Latin America *Transition timescale: 50-100yrs* Realistic possibility of collapse starting from 2050	*Low confidence*
2	**Congo Basin** Africa *Transition timescale: Uncertain* Realistic possibility of collapse starting from 2050	*Low confidence*
3	**Coral reefs** SE Asia *Transition timescale: 10 years* Realistic possibility of collapse starting from 2030 **Mangroves** SE Asia *Transition timescale: Uncertain* Realistic possibility of collapse starting from 2050	*Medium confidence*
4	**Himalayas** Asia *Transition timescale: 50-1000yrs* Realistic possibility of collapse starting from 2030	*Medium confidence*
5	**Boreal forests** Russia *Transition timescale: 40-100yrs* Realistic possibility of collapse starting from 2030	*Low confidence*
6	**Boreal forests** Canada *Transition timescale: 40-100yrs* Realistic possibility of collapse starting from 2030	*Low confidence*

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.

Ecosystem degradation or collapse will challenge the UK's food security

The UK relies on global markets for its food and for fertiliser. The UK imports 40% of its food from overseas, with over 25% coming from Europe.[16] The UK is heavily reliant on imports for fresh fruit, vegetables and sugar. Animal farming at current levels is unsustainable without imports - soy from South America makes up 18% of produced animal feed.[17] Nearly 50% of packaged products contain imported palm oil.[18] The UK is not self-sufficient in fertiliser - for both nitrogen and phosphorus it is partially reliant on imports. Global phosphorus production is dominated by China and Morocco.

The UK is unable to be food self-sufficient at present, based on current diets and prices. Full self sufficiency would require very substantial price increases for consumers, as well as improvements in efficiency, waste reduction and resilience across the food system, including agricultural production, food processing, distribution and consumption. The UK does not have enough land to feed its population and rear livestock: a wholesale change in consumer diets would be required. It would also require greater investment in the agri-food sector so that it is capable of innovating in sustainable food production.

UK food production is vulnerable to ecosystem degradation and collapse. Biodiversity loss, alongside climate change, is amongst the biggest medium to long term threat to domestic food production - through depleted soils, loss of pollinators, drought and flood conditions. Ecosystem collapse would place the UK's agriculture system under great stress, leaving it struggling to pivot to the new approaches and technologies that would be required to maintain food supply.

Ecosystem degradation or collapse affecting major food producing regions would increase resource scarcity and drive up global food prices. There is high uncertainty about how this would play out. The geopolitical response, as well as the extent and timing of ecosystem collapse, would determine whether and how quickly global markets are able to respond. Collapse of production in two or more breadbasket regions would almost certainly significantly drive up global food prices, potentially limiting the UK's ability to import food, impacting household food security and restricting diets.

Significant disruption to international markets as a result of ecosystem degradation or collapse will put UK food security at risk. Global scarcity would drive greater state intervention in supply chains, and securitisation of and conflict over food and water.

Some technologies exist that could help, but need significant research, development and investment to have a chance of working at scale. Protecting and restoring ecosystems is easier, cheaper and more reliable. The time required to develop and scale technologies is unknown without further research. Both existing (plant pre-breeding, regenerative agriculture) and emerging technologies (AI, lab grown protein, insect protein) offer potential solutions.

Annex A | **Glossary**

Biodiversity: the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems.

Cascading risk: cascading risks occur when an adverse impact triggers or amplifies other risks. For instance, in 2010 western Russia experienced an unprecedented heatwave, drought, and series of wildfires, destroying 17% of the wheat harvest. Russia banned wheat exports, resulting in sharp international price rises. This led to increased food bank usage in the UK and a rise in poverty and political unrest in countries such as Egypt, Tunisia and Mozambique. This was one of many factors that contributed to the Arab Spring in 2011.

Ecosystem: a community of living organisms (plants, animals, fungi and various microbes) in conjunction with the non-living components of their environment (such as energy, air, water and mineral soil), all interacting as a system.

Ecosystem collapse: refers to a critical threshold beyond which an ecosystem is potentially irreversibly changed and can no longer maintain essential structure or function, with extensive shifts to their size or extent, or the species that comprise them. These losses tend to homogenise and simplify the ecosystem, leaving fewer species, fewer habitats and fewer connections between the two. As a result, the ecosystem's ability to provide vital services—such as clean water, pollination, and climate regulation—may be significantly and permanently impaired. The consequences of ecosystem collapse extend beyond ecological impacts, affecting human well-being, economic stability, and food security.

Ecosystem degradation: a long-term reduction in an ecosystem's structure, functionality, or capacity to provide benefits to people.

Ecosystem services: the benefits that people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; and cultural services such as recreation and sense of place.

Food security: when all people, at all times, have physical and economic access to sufficient safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life.

Food self-sufficiency: a food production to supply ratio of 100%, calculated in the UK as the farmgate value of raw food production divided by the value of raw food for human consumption.[20]

Nature: encompassing both the non-living components (i.e. geodiversity) and the living components (i.e. biodiversity) of the natural world.

Planetary boundaries: the safe limits for human pressure on the nine critical processes which together maintain a stable and resilient Earth.

Tipping point (ecological): a set of conditions of an ecological system where further perturbation will cause change to a new state and prevent the system from returning to its former state.

Annex B | **Methodology - identifying critical ecosystems**

To identify critical ecosystems of concern for the UK, we conducted a wide ranging literature review and sought the views of 81 experts within and outside government.

1. **Literature review.** We conducted a literature review to identify features of ecosystems which would make them a concern for the UK. We searched for studies that: (a) classify ecosystems with a specific value beyond their biome type, such as their contributions to people or marine resource dependency; (b) are at a global scale; and (c) with openly accessible geospatial datasets. We chose to include studies which applied a consistent assessment type at global scale (criteria (b)) to avoid oversaturation of sub-national ecosystem assessments which would require detailed meta-analysis methodologies (and the problems they entail). We initially discerned 10 distinctive features of concern.

2. **Expert workshops to identify features of concern.** We conducted a series of five expert elicitation exercises with 81 biodiversity experts from across a range of disciplines, to (1) achieve a more comprehensive range of features of concern and (2) prioritise those features of concern for impact against the UK. The first step returned an additional possible 24 features of concern. Post-workshop refinement against the inclusion criteria reduced this to three. Experts were then asked to vote for five features of concern that would most impact the UK.

   The top five ecological features of concern identified by experts are shown opposite.

3. **Identifying ecosystems with features of concern.** We then identified the specific ecosystems described within the reference studies and assessed them for co-occurrence against the top five features of concern. Using co-occurrence scores, we identified what we call Geographic Regions of strategic Ecological Importance for the UK. (GeoREI-UK). We define a GeoREI as bounded geographic regions that contain co-located ecosystems/singular ecoregions that have at least three of the features of concern for high UK impact.

Ecological features of concern

Expert votes (/ 81)

Scale of Impact *(70)*

Source: Global Tipping Points Report, 2023 [21]

A critical transition of these ecosystems leading to (i) potentially altering the entire earth system, (ii) affecting >~1000m people and (iii) is likely to be irrecoverable.

Degradation to Quality of Life *(45)*

Source: Source: Díaz et al., Assessing nature's contributions to people. Science 2018 [22]

Biodiversity loss and other stresses on these ecosystems reduces Nature's Contribution to People (NCP) defined as all the contributions both positive and negative of living nature to people's quality of life.

Speed of Collapse *(35)*

Source: IUCN Red List of Ecosystems database, 2024; Genin et al., Mapping hotspots of potential ecosystem fragility using commonly available spatial data, Biological Conservation, 2020 [23,24]

Disproportional changes in an ecosystem state occur following gradual changes in environmental conditions.

Irrecoverable Carbon *(31)*

Source: Noon et al., Mapping the irrecoverable carbon in Earth's ecosystems, Nat Sustain, 2022 [25]

Identified carbon reserves (ecoregions) that are manageable, vulnerable to disturbance and could not be recovered by 2050 if lost today.

Intactness *(29)*

Source: Natural History Museum, Biodiversity Intactness Index database, 2021 [26]

The estimated percentage of the original number of species that remain and their abundance in any given area, despite human impacts.

Annex C | **Scientific references**

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