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# Environmental foresight review

## Analysis and implications of the existing evidence in environmental foresight for the Office for Environmental Protection

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# Executive summary

The UK, and the world as a whole, faces profound challenges in the transition to a less environmentally damaging future. Foresight and forecasting studies play an important role in this transition process by helping to present the potential future consequences of our decision-making and activities. Such studies, in turn, help to inform a range of decisions with the potential to improve the odds of achieving futures we want and reduce the odds of the futures we want to avoid. In particular, foresight and forecasting can help to:

- **Enhance Preparedness and Resilience:** Foresight helps anticipate future environmental challenges, reducing the likelihood of "nasty surprises" and promoting proactive responses.
- **Reduce Short-Termism:** By providing a clearer understanding of potential future consequences, foresight encourages long-term thinking and reduces the tendency to prioritize immediate gains over sustainable solutions.
- **Improve Decision-Making:** Foresight studies, whether they reduce uncertainties or help manage unavoidable ones, ultimately contribute to better-informed and more timely decisions regarding environmental protection and improvement.

Despite these benefits, often the impact of foresight and forecasting studies can be limited as these studies often don't directly translate insights into actionable policy recommendations. Additionally, these types of studies tend to have a siloed approach, neglecting the crucial interdependencies between different environmental issues and Environmental Improvement Plan (EIP) goal areas.

The challenges that Defra's EIP seeks to address are long-term, requiring a clear vision of the future and an understanding of important waypoints and decisions that help organisations to arrive at their preferred future outcome.

In this context, the OEP's mission to hold the English and Northern Ireland governments to account in their efforts to protect and enhance the natural environment addresses a key aspect of this decision-making, and in particular, the ways in which government departments and agencies make use of foresight and forecasting studies to improve this aspect of public policy and its delivery.

In the light of the importance of this challenge, the Office for Environmental Protection (OEP) commissioned Ipsos UK to conduct an evidence review of existing foresight and forecasting studies on the environment and natural world.

The aim of this study is to understand the diverse approaches used in environmental foresight, identify where there are gaps and concentrations of existing evidence across the ten Goal areas of the EIP and develop recommendations to enhance the OEP's foresight capabilities.

The research conducted by Ipsos involved interviews with environmental foresight experts, a documentary evidence review and synthesis, and consultations with an internal Advisory Board.[1] From

[1] The Internal Advisory Board comprised Directors from Ipsos' Environment and Energy, Trends & Foresight, and Strategy and Advisory teams. This board guided our work and acted as the quality assurance for the project.

this research, Ipsos identified 202 relevant studies for the evidence longlist, which were categorized and shortlisted through a multistage process, resulting in 88 sources that were taken forward to the synthesis stage of the project for in-depth analysis.

The analysis revealed key findings on common inputs, processes, and outputs across the studies:

- Among shortlisted studies, there are clear similarities in the considerations of factors that are driving the future of the natural world, mostly related to environmental and social change factors.
- Few studies address the interdependencies between these factors. Most sources take a linear or causal view on how change is driven and do not address the inherent interrelationships between factors.
- Uncertainties are an inevitable feature of futures-oriented work, and inevitably limit and cause risks in policymaking.
- There is a clear division between quantitative and qualitative processes, and a limited number of studies attempt to bridge this gap to create a more comprehensive approach and nuanced understanding of what the future of the natural environment might look like.
- Outputs of the assessed studies are broadly exploratory, showing a range of plausible future developments. There is less emphasis on mapping the impacts of new policies into the future, or considering the steps that might be required to meet existing goals.
- Many of the foresight and forecasting assessed studies address multiple EIP goal areas, demonstrating the interdependencies between EIP goal areas.
- Lastly, the significant limited (human) resources required to analyse and convert foresight and forecasting studies creates a risk of overlooking useful evidence and insights relevant to environmental policymaking.

Based on the conducted evidence review and Advisory Board input, recommendations for the OEP are structured around four areas:

- **Further focus on discovery**: future research as well as data sources gathering that might support further foresight and forecasting should focus as much, if not more, on building relationships across organisations, rather than improving search approaches.
- **Approaches to Horizon scanning**: this should be multilayered, looking beyond existing social and demographic factors. Horizon scanning methodologies should derive potential insights from the top down (driven by global macro forces), the middle out (from developments in culture, opinions, attitudes and values), and the bottom up (new innovations and behaviours by individuals that could accumulate over time and cause systemic change).
- **Greater focus on reflexive futures - backcasting and policy testing**: working backwards from preferable visions of the future of the environment where the EIP goals are promoted could help explore which policy actions the government should be taking now to make this future happen.
- **Publicising scenarios to promote behaviour change**: many studies in the shortlist do not consider how the outputs could be used to influence and shape future policy. Raising awareness of

what the future could look like based on current trends – and the likely negative consequences – could focus the attention of policymakers, and the public, to take further actions.

These findings will be instrumental in informing the OEP's approach to foresight and forecasting and enhancing its role in monitoring Government performance against the EIP.

## Further considerations for the OEP

Some additional strategic recommendations are also provided that relate to the use and interpretation of futures studies.

1. If the OEP commissions any foresight and forecasting studies directly, this should emulate the modern medical journal approach and specify that any policy implications be noted at the end of the report.

2. OEP could liaise with research councils, departments and agencies, and think-tanks NGOs to increase the emphasis on noting any policy implications – as this may not naturally be done by all authors (especially academics).

3. OEP could assess the current effectiveness of internal analytical capability to deliver a policy translation bridge linking foresight and forecasting studies more effectively with OEP's mission.

4. OEP should consider encouraging a closer examination of goal area inter-dependencies by foresight and forecasting study funders (especially research councils and other departments and agencies).

5. OEP should consider mapping the key goal area inter-dependencies that shape environmental futures against departmental responsibilities, with the aim of identifying any gaps that fall between these responsibilities. This gap analysis will be important in holding government to account from a 'joined-up' perspective.

6. It may be worth the OEP learning from more comprehensive and integrated 'grand strategy' approaches in this context.

7. It may be worth the OEP explores the use of AI to assist analysing foresight and forecasting studies, allowing a far larger number of studies to be examined and reducing risks of sample selection biases and gaps.

# 1. Introduction

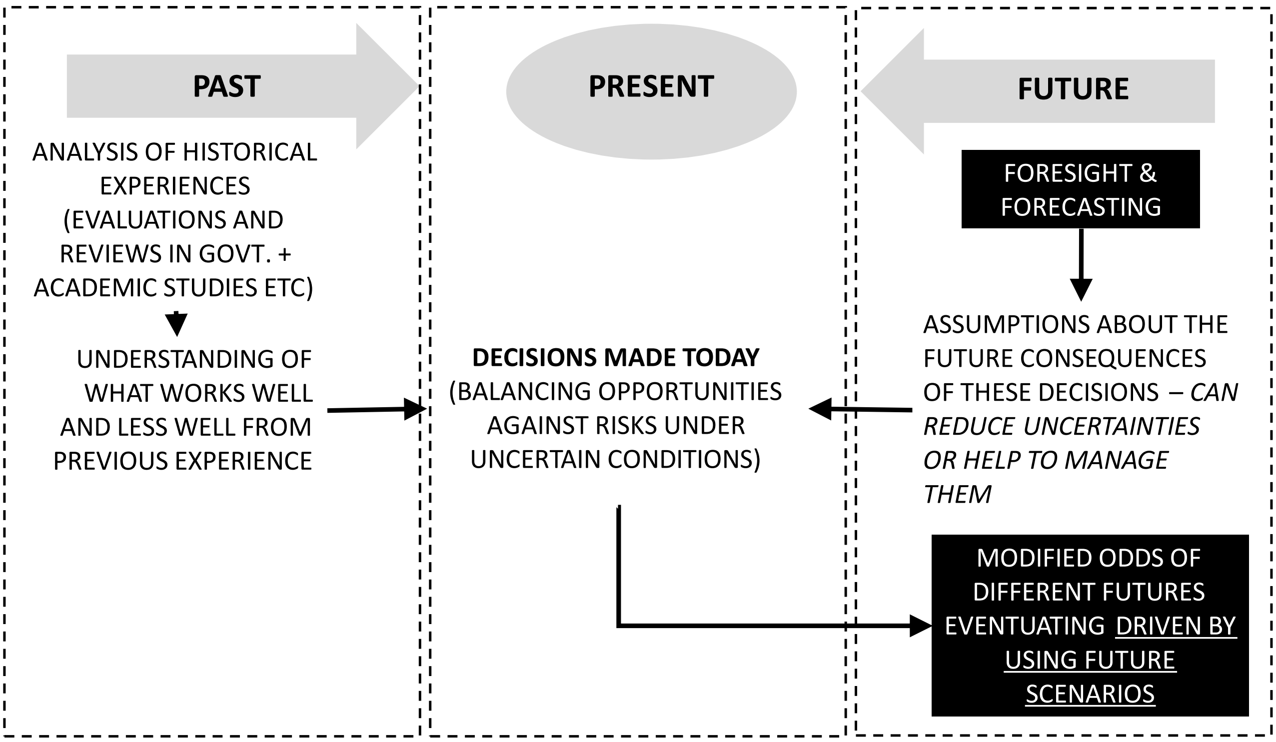
## The policy challenge

The UK and the world as a whole, faces profound challenges in the transition to a less environmentally damaging future. Foresight and forecasting studies play an important role in this transition process by helping to set out the potential future consequences of our decision-making and activities. Such studies, in turn, help to inform a range of decisions with the potential to improve the odds of achieving futures we want and reduce the odds of the futures we want to avoid.

This relationship is summarised in the diagram below (Figure 1), which highlights how foresight and forecasting studies play a useful role in reducing uncertainties over future states of the world, and, in so doing, informing current decision-making.

Foresight and forecasting studies do not need to be, and indeed can rarely be, 'correct' as predictions. Rather, their utility in public policy stems from the ways in which they help to transform a complex and highly uncertain general sense of what the future may have in store into more easily grasped and understood concepts and projections. This is a complex aspect to consider because the role of foresight and forecasting studies spans the spectrum from identifying potentially novel future conditions through to assisting in managing 'known' uncertainties. ***Any*** **reduction in this uncertainty, and/or assistance to managing unavoidable uncertainties helps government departments and agencies (and businesses and the general community) to make better-informed and more timely decisions that will shape how the future unfolds.**

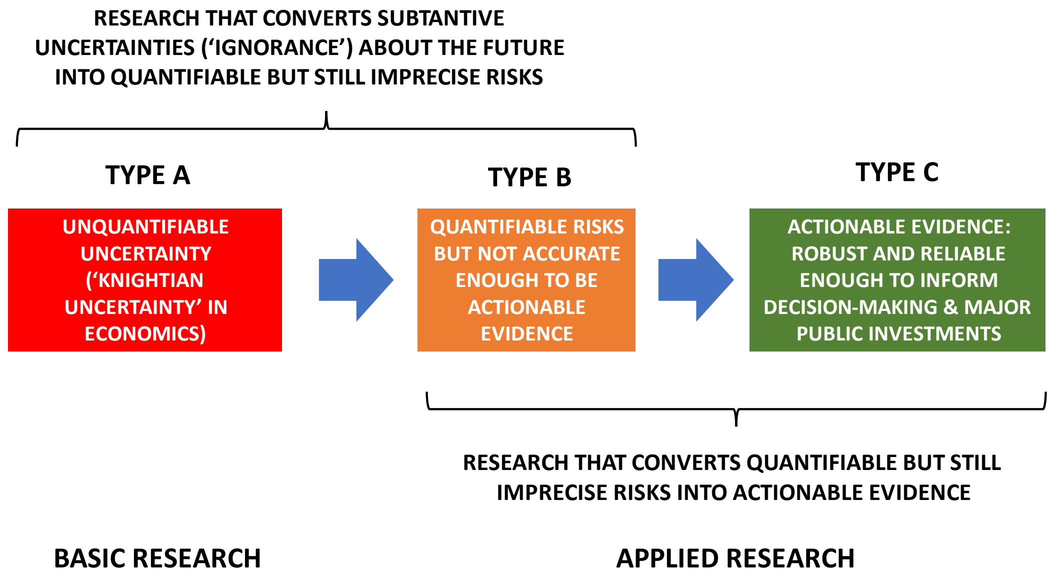
**Figure 1: Futures work and decision-making diagram**




Source: Ipsos

Figure 2, below, highlights the special case in which some types of futures work can inform us about new and/or previously unknown risks. In this situation, the present-day benefits go beyond simply helping us to manage future environmental risks and extend into alerting us to new threats that may require further investigation and/or government policy responses. As the diagram highlights, the importance of this type of study is that it translates unquantifiable/substantive uncertainties into quantifiable risks, and, potentially then into sufficiently robust evidence to inform government actions. In this transition, academic work can alert us to new and unexpected environmental threats, setting in train further research aimed at discovering more about these threats. This (ideally) results in sufficient improvements in the quality of the evidence to allow for government actions to be taken.

**Figure 2: Why some types of futures information can identify new previously unknown risks**




Source: Ipsos

Holding government to account in this particular context involves assessing how fast and effectively departments and agencies are identifying and acting upon new and unexpected environmental threats.

The benefits thus created stem from boosted preparedness and resilience (nasty surprises are less likely) and from important factors such as reduced 'short-termism'/myopia over the future. In economic terms, a lower social rate of time preference driven by a better sense of what the future may have in store for us. So, what matters is that these studies either 'whittle down' uncertainties over the future, or help us to manage unavoidable uncertainties, in ways that shape current and future decision-making.

Both of these aspects are very important to policy-making, and therefore to the OEP's role. However, there is the well-known challenge that foresight and forecasting studies, both in their Terms of Reference and in how they are delivered may not address policy implications or make specific policy suggestions. Consequently, the nature, extent and adequacy of this 'bridging' function between foresight and forecasting studies and policy will tend to determine how effectively government acts in response to such work. As this bridge is necessary to determine whether government departments and agencies are doing an effective job in reacting to the important messages from foresight and forecasting work, any limitation in this analytical function will have knock-on effects for the OEP. We return to this issue at the conclusion of this report. Other complementary challenges for government in this area stem from the existence of ‘systemic’ effects and interdependencies that link aspects of what departments and agencies are doing and attempting to do. The transition to a more environmentally sustainable future involves ‘de-siloing’ both our foresight and forecasting work and (where possible) the policies and strategies of numerous departments and agencies.

De-siloing’ our foresight and forecasting work is important because the future is created by the interplay between different aspects of the economy, society and the environment. For example, the natural environment faces multiple threats including increasing human consumption, land use change, and economic power shifts.[2] However, an important challenge is that the delivery of foresight and forecasting tends to be organised around academic disciplines and subject areas and/or in line with clearly demarcated departmental responsibilities. This generates a risk that foresight and forecasting studies focus closely on specific remits and pay less attention to cross-cutting interdependencies. This can create a gap between our framing of the assessment of potential future conditions, the causal relationships that create these conditions, and the actual ways in which environmental degradation (and efforts to improve the environment) take place.

De-siloing’ governance is important because these interactions can span different departments and agencies’ jurisdictions and responsibilities. This is why the ‘grand strategy’ approaches more commonly used in defence and national security that connect and coordinate many arms of government under a shared transition and coordinated agenda are so relevant to dealing with environmental challenges. Without this coordination, and the resulting coherence, policy effectiveness can be constrained by the ways in which useful inter-dependencies are neglected and unhelpful problems that lie between different departmental responsibilities can be overlooked or neglected.

From this perspective, the OEP’s role in holding the English and Northern Ireland governments to account over environmental protection and improvement can, in theory, be usefully informed by foresight and forecasting studies because such work draws attention to future environmental challenges faced, and the potential for government departments and agencies to address these challenges. In practice, however, the ways in which such studies are framed and how complex interdependencies between different aspects of the environment are considered (if they are considered) will determine how useful foresight and forecasting studies are to the OEP in delivering its mission. Given the tendency of the Westminster system (and indeed most forms of government) to approach policy challenges from department and agency-specific perspectives this ‘de-siloing’ work has a special importance to OEP’s mission. This reinforces the importance of de-siloing foresight and forecasting work by considering the inter-dependencies between discrete studies.

A final practical consideration is that of resourcing the analysis of foresight and forecasting studies given the large number available. The need to prioritise the studies examined (as this project needed to do) introduces a risk of selection bias and also ‘blind spots’ (potentially important future opportunities and threats overlooked simply because the studies were not identified and/or read). Modern AI solutions are able to play a useful role in this regard, and we return to this issue at the conclusion to this report.

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[2] Kass, G. S et al (2011) *Securing the future of the natural environment: using scenarios to anticipate challenges to biodiversity, landscapes and public engagement with nature*. Available at: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2664.2011.02055.x

## Background to this study

The Office for Environmental Protection (OEP) has a pivotal role in the fight to improve environmental standards. It is an independent and statutory body that oversees the Government's performance on the natural environment in England and Northern Ireland. The OEP's statutory role allows it to scrutinise the government Environmental Improvement Plan (EIP) and the implementation of environmental law, advise on proposed changes to existing environmental law and take enforcement action against failures to comply with environmental law. Its broad remit covers not only government departments and ministers, but regulators, local authorities and the public powers and duties of some private organisations.

OEP's latest progress report of the government's EIP found that the "government remains largely off track to meets its environmental ambitions and must speed up and scale up its efforts in order to achieve them",[3] meaning that holding government to account is more important than ever. The OEP is working on strengthening its assessment methods to ensure the government is accountable to deliver its stated goals and targets. These assessments necessitate an understanding of the crucial trends, issues, policies, and actions that shape the future environment in England and Northern Ireland. Therefore, the OEP sought to systematically review and critically assess the diverse approaches and evidence available for anticipating environmental futures and evaluating pathways towards achieving stated goals and targets.

Ipsos UK was commissioned by the OEP in June 2023 to conduct an evidence review to scope, review and synthesise existing foresight and forecasting studies on the environment and natural world. This review is intended to identify where there are gaps and concentrations of existing evidence across the ten EIP goal areas and to provide a baseline understanding of the diverse approaches used in this space. Ipsos also produced recommendations that can inform the development of the OEP's foresight capabilities, which will help it fulfil its statutory role of monitoring Government performance against the EIP.

## Our approach

The Ipsos approach is built on an evidence review of existing foresight and forecasting studies focussed on the natural world. Foresight studies commonly use qualitative approaches to look at the future of the environment, for example by using scenario planning or Delphi methods, and often focus on longer term futures.[4] Forecasting studies take a quantitative approach, which often includes modelling and projections, and normally concentrate on short to medium term futures.[5] The evidence review was supplemented by nine interviews with environmental foresight and forecasting practitioners who have helped to set the scope of the work. In addition, Ipsos has consulted with an internal Advisory Board of environmental and foresight experts within the company throughout the study. They have shaped the project at strategic points and provided reflections that inform the recommendations of this work.

A brief overview of the research process is provided below.

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[3] https://www.theoep.org.uk/report/government-remains-largely-track-meet-its-environmental-ambitions-finds-oep-annual-progress
[4] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/674209/futures-toolkit-edition-1.pdf
[5] https://www.frias.uni-freiburg.de/en/funding-programmes/foci/environmental-forecasting

## Evidence review: longlist

The core of this project was a systematic evidence review, which sought to identify and analyse relevant foresight and forecasting studies. It should be noted that this is different to a review of sources of foresight evidence, as some evidence is in the form of datasets; we reflect on this difference later in the report.

Following a kick-off meeting, Ipsos agreed a set of key search terms (detailed in the methodological appendices) structured around the ten EIP Goal Areas that inform the OEP's work:

1. Clean air
2. Clean and plentiful water
3. Thriving plants and wildlife
4. Reduced risk of harm from environmental hazards
5. Using resources from nature more sustainably and efficiently
6. Enhancing beauty, heritage and engagement with the natural environment
7. Mitigating and adapting to climate change
8. Minimising waste and resource use
9. Managing exposure to chemicals and pesticides
10. Enhancing biosecurity

In total, 202 studies were identified for the evidence longlist. These were summarised and categorised against a PESTLE[6] framework to provide an overview of the nature of the evidence base.

While the evidence review was ongoing, Ipsos also conducted a set of nine expert scoping interviews. These interviews were held with foresight and policy experts from across government, the third sector and private sector, including Natural England, Defra, the Climate Change Committee, Natural Resources Wales, Wildlife and Countryside Link and the School of International Futures. We wanted to understand their view on environmental foresight and important sources for the review, as well as reflections for how foresight can be used to inform environmental policy and the role the OEP could play in this space.

## Shortlisting and analysis

The full study list was assessed through a multi-stage shortlisting process (detailed in full in the methodological appendices).

- The first stage was to sift the sources based on their geographical relevance to the UK context (UK-based studies were preferred) and the transparency with which they reported the methods that had been used in the foresight or forecasting process.

[6] Political, Economic, Social, Technological, Legal and Environmental

- This was followed by a second stage assessing how relevant each source was to the OEP's EIP goals as well as the foresight and forecasting approaches which had been used.

Following these stages, the shortlist was reviewed to ensure the process had prioritised the most relevant studies and a quick review of sources not in the shortlist was also conducted to avoid losing important studies. OEP reviewed the longlist and was also sent the list of sources that did not make the shortlist, they then flagged the sources they felt were important to retain and they were added into the shortlist. The result was a shortlist of 88 sources that were taken forward into analysis, and a framework for assessing the quality of environmental foresight and forecasting was developed, which is included as an appendix to this report.

In the analysis phase, all shortlisted studies were read in depth to understand their detailed approach to foresight and forecasting. The key questions for analysis, developed in partnership with the OEP and which framed the reading process, were structured into three groups, detailed below:

- Inputs
  - What emerging trends and long-standing drivers of change have been used to inform foresight and forecasting exercises?
  - What are the key sources of uncertainty that have been identified? How have these, if at all, been quantified or structured?
- Process/analysis
  - How have scenarios or pathways/projections been developed in the evidence? What structures and frameworks have been used?
  - How, if at all, have uncertainties – provocations and 'wild cards' – been incorporated into the process?
- Outputs and outcomes
  - What are the outputs of the work and what aspects of the future environment did they focus on? How are scenarios or projections, key uncertainties and questions or other outputs presented?
  - What outcomes are derived from the work? How (if at all) are these outcomes quantified and how are they proposed to be monitored or updated?
  - How, if at all, is uncertainty being acknowledged or incorporated into recommendations derived from the outcomes?

This report details the findings from this detailed analysis of the foresight and forecasting study shortlist. First, it presents the cross-cutting reflections from the analysis which reflect the key patterns and trends that emerge across the studies and that are important for the OEP's approach to foresight and forecasting generally. These reflections are structured by the key questions that were asked during the analytical phase. At the end of each section, it focusses on the nature of the evidence base within six of the ten EIP goal areas, which can inform how the OEP approaches some of its more detailed goal area work. The selected six goals were Thriving plants and wildlife, Using resources from nature more sustainably and efficiently, Mitigating and adapting to climate change, Clean and plentiful water, Clean air, and Minimising waste. These were selected by the OEP on the basis that they demonstrate evidence divergence and commonality. They also provided a good spread in terms of total number of studies, and analytical process (qualitative/quantitative methodology). It ends with reflections on how the OEP could react to build its role in environmental foresight and use the findings from these studies in its work holding government account.

### Methodological limitations and challenges

This evidence review is not free of inherent selection bias and risk of overlooking useful evidence. This project has focussed on published and readily accessible studies of foresight and forecasting with relevance to topics associated with the natural world including biodiversity, water and air quality and the impacts of climate change. The method that has been employed means that there may be gaps in the evidence base: for example, datasets (which often inform forecasting studies), unpublished studies and grey literature may not have been identified. Therefore, most of the publications in this study is peer-reviewed academic literature. It should not be taken as a comprehensive review of all studies, data and reports that exist in the area. However, it provides a clear picture of the published studies that exist and highlights areas where there is less published information that may require further focus in future.

The process of shortlisting the studies was not found to have significantly altered the balance across the goal areas, however some goal areas saw greater reductions in the number of studies between the full long list and the final shortlist. The largest drops were in Using resources from nature more sustainably and efficiently, Enhanced beauty, heritage and engagement with the natural environment and Minimising waste. This suggests that the existing studies in these areas may be of more variable quality or have less relevance to the UK than others.

## Structure of the report

The remainder of the report will be structured as follows:

- Chapter 2. Inputs into environmental futures work: presents the identified inputs into environmental futures work – these are the factors that are driving the future of the natural world.
- Chapter 3. Process and analysis: sets out how futures work has been generated.
- Chapter 4. Outputs and Outcomes: details the outputs and outcomes – these are the conclusions and recommendations that the studies are making about the future of the natural environment.
- Chapter 5. Analysis of goal interdependencies: provides a quantitative assessment of the nature and the extent of the goal interdependencies.
- Chapter 6. Implications: details the implications in terms of the key findings for OEP's mission.

# 2. Inputs into environmental futures work

**Key takeaway**

Among all studies in the shortlist there are clear similarities in the inputs, that is, the factors that are driving the future of the natural world. Viewed through the PESTLE lens, the driving forces are primarily related to environmental and social change factors. These affect political, technological and regulatory responses, which in turn have economic consequences.

Few studies address interdependencies between these factors. Most sources take a linear or causal view on how change is driven and do not address the inherent interrelation between PESTLE factors (even at the outcome stage). However, many studies address multiple EIP goal areas, reflecting the important interdependencies between different EIP goal areas.

## Overview

An analysis of the PESTLE categorisation of the shortlisted studies reveals that environmental and social factors were most commonly highlighted as drivers of the future for the natural environment.

Within the environmental drivers, the impacts of climate change (e.g. rising temperatures and changes to the distribution and habitat of species) were naturally predominant, alongside land use change, pollution levels and changes to crop calendars. The social factors that were held in common across studies were typically large-scale forces such as ageing, urbanisation and changing demography rather than changes in values or attitudes among people as citizens or consumers.

Economic drivers were the third most-common factor. Key aspects highlighted in the evidence base include agriculture prices and productivity and household consumption – although often these were seen as being the results of changes driven by social and environmental factors, technological innovation, or political and regulatory change.

Studies with technological, political, and legal or regulatory foci were least common in the evidence base. Key drivers identified in these studies include advances in biotechnology, clean energy access and flood warning systems for technology, and pollution targets, environmental policies and global governance mechanisms for political and regulatory factors. Often in the shortlisted foresight and forecasting studies, these types of drivers were framed as responses to changing environmental and social factors. While these inputs were common across the shortlisted studies, it should be considered that inputs often reflect the interests of organisations conducting or commissioning research, rather than the real-world system drivers.

The pattern of social and environmental factors driving systems, which elicit technological, political and regulatory responses, with economic impacts, was commonly repeated across the evidence base in a linear fashion. Many of the studies followed this approach to foresight and forecasting, identifying factors that influence responses and determining the resulting impact. Whether quantitative or qualitative study, there was generally a linear segmentation of how these drivers are considered.

In this linear view, environmental factors are seen as the biggest drivers of change of environmental futures. Similarly, social drivers are also present in the evidence base as relevant drivers of change.

Environmental and social factors are then seen as the background against which political and regulatory issues may result. The impact of new policies and their subsequent influence on the environmental outlook was less prevalent in the evidence base. Subsequently, technological factors are seen as responses to address those problems, followed by the economic impact of them. For example, technology was often described as the innovation needed to meet the climate challenge, followed by the call for investment into this innovation.

This more linear view of foresight and forecasting does not reflect the circularity of how these drivers can impact environmental futures. There appears to be a gap in the analysis of how these impacts might, in turn, affect society and the broader environmental landscape. This standard linear process observed in the studies highlights the need for a more comprehensive approach that considers the complex interactions between various drivers, impacts, and policy responses to better understand and influence the future environmental picture. However, this approach would bring challenges. Defining the scope of driver assessments is problematic since there is a vast list of factors that can influence environmental futures, making it difficult to determine which ones should be included. Secondly, when it then comes to analysing the interdependencies between these drivers, untangling the relationships between them, and identifying what is driving what is not always clear.

The shortlisted studies all acknowledged the important role uncertainty can play in anticipating the future. This included both quantitative forecasting and more qualitative foresight exercises. This was probably due to the shortlisting process which prioritised sources that are more transparent in their treatment of uncertainty (detailed in the appendices). The concept of uncertainty encompasses both knowable and unknowable aspects, extending across both quantitative and qualitative research methodologies.

- Knowable uncertainties: In many of the quantitative and modelling goal-based studies – and especially in more quantifiable EIP goal areas like clear air – uncertainty was typified as a known and reducible factor. Uncertainty could be reduced by improving data availability, enhancing spatial resolution, or improving the detail or accuracy of modelling. It could also be acknowledged through adding confidence intervals and error bars to projections of future states.
- Open-ended uncertainties: The qualitative and foresight studies tended to focus on open-ended uncertainties such as unpredictable events (wildcards or black swan events). These studies also focussed more on the potential for unintended consequences from interactions between existing drivers.

While quantitative studies often focus on knowable uncertainties that can be reduced through improved data availability or modelling accuracy, qualitative studies tend to emphasize open-ended uncertainties, such as unpredictable events or unintended consequences. The nature of uncertainty also varies across different goal areas. In some areas, such as Clean air, and papers that explored flood risk, the means by which the futures studies are generated exhibit some knowable uncertainties in terms of how data is collected to inform forecasting approaches. These can be addressed through improving empirical data collection and modelling refinement. However, other areas, such as land use and food security, deal with broader social uncertainties that cannot be resolved through such measures. These uncertainties require a different approach, such as scenario planning and expert workshops to identify potential drivers of change and their implications.

Often, the treatment of uncertainty in the shortlisted studies aligned with the methodological approach they used, and very little overlap was observed. Quantitative studies typically employed confidence intervals and error bars to acknowledge uncertainty, while qualitative studies utilize scenario analysis and expert consultation to explore open-ended uncertainties.

## Inputs across goal areas

Conducting a deeper analysis of the shortlisted studies by goal area showed that there is significant overlap between inputs across goal areas, most notably between Thriving plants and wildlife, Using resources from nature more sustainably and efficiently and Mitigating and adapting to climate change. Considering the established pattern of how social and environmental factors are the most common factors that act as catalysts for change in environmental futures work, it is unsurprising that common observed drivers across goal areas are population growth, land use change, urbanisation and the effects of climate change.

Some shortlisted studies did acknowledge the interrelations between some drivers, usually between social and environmental ones. For instances, between how a growing population leads to increased demand for resources, such as water and food, and also amplifies the need for urban spaces, pushing for the conversion of natural habitats into human settlements. This in turn can trigger significant ecological changes, including biodiversity loss and habitat fragmentation as infrastructure is developed.

It is encouraging to see environmental futures considering the interrelations between multiple drivers, as this illustrates a more holistic view of the relationship between drivers, enriching outputs. Despite this, only few studies comprehensively analysed the interplay of all political, social, technological, economic, legal, and environmental factors. This could be associated with the high complexity of the nature of the issues being explored, in addition to the intrinsic complexity of some quantitative approaches such as modelling. This makes it hard to analyse the interplay of multiple drivers together. Often quantitative approaches only focus on the most impactful drivers, in order to deal with this complexity. But robust environmental futures work needs to consider all of the diverse factors at play.

In addition to the prevalence of population growth, land use change, urbanisation and the effects of climate change as drivers, there were also some drivers specific to different goal areas. For instance, the Thriving plants and wildlife goal area highlighted the development of nanotechnologies, biodegradable products, and soft robotics as technological drivers, which impacted biodiversity. Each was seen as a potential benefit or opportunity that could positively influence the environment. Yet these could also drive potential new challenges, such as the invasive potential of artificial life and unintended consequences of modern biotechnology. This was one of the few examples present in the shortlisted studies where wildcards[7] were incorporated into futures work.

Other technological drivers were prominent in Using resources from nature more sustainably and efficiently and Mitigating and adapting to climate change goal areas. Fast paced technological change, including developments in the agriculture sector and flood defence and warning systems were considered as key issues driving change.

Climate and environmental policy were also seen as an important driver for Thriving plants and wildlife and Clean air goal areas. Studies referenced specific global policies and governance mechanisms, such as the Paris Agreement on Climate Change, the Convention of Biological Diversity, pollution targets and

[7] Wildcards are unexpected, low-probability, high-impact events that can drastically change the trajectory of the future and are highly important to consider in the context of environmental systems which are highly uncertain and complex.

carbon pricing as legal and regulatory drivers informing their foresight work. Policy making processes were frequently mentioned. However, they were not usually incorporated as typical long-term drivers in the futures work, which is not surprising due to the brevity of political cycles.

# 3. Process and analysis

**Key takeaway**

There is a clear division between quantitative and qualitative processes, with studies in individual goal areas tending to fall into one or the other category. The mix of analytical approaches employed varied across key goal areas.

The number of studies that attempt to bridge this gap to create a more comprehensive approach and nuanced understanding of what the future of the natural environment might look to the future is limited.

## Overview

The evidence base was largely quantitative, with almost half of the studies being predominantly quantitative, around a third being mixed methods and the final fifth being qualitative-led. This informs the types of foresight and forecasting processes that are common across the shortlist.

- As expected, a large number of the forecasting studies focused on projections. These include projected outcomes of continuing the status quo in a particular policy area under different climate change scenarios. For instance, one study projected what might happen to flood risk in the UK under different future scenarios, if current flood risk management strategies continue unchanged. This served as a baseline scenario to compare the effectiveness of different flood management approaches,[8] as well as likely future scenarios under different climate change or socio-economic pathways.

- It was not surprising to find that qualitative scenario narratives were frequently used in foresight studies. These tended to focus on reconciling economic growth with sustainability by describing visions of world where one or the other was given more policy priority.[9]

- It was less common for studies to combine these key method types, except in more limited case study examples. However, one study in the shortlist developed a methodology that combined the foresight approach of backcasting to identify pathways towards desirable long-term goals, which can then be met through adaptive management techniques that use iterative decision-making, monitoring and adjustment of strategies to reach the original vision. Its applicability was demonstrated using a case study of a coastal region in South Africa.[10]

The mix of analytical approaches employed varied across key goal areas. The goal areas with the most studies in the shortlist – Thriving plants and wildlife, Using resources from nature more sustainably and efficiently, and Mitigating and adapting to climate change – all had a mix of methods, although the study base for biodiversity was a little more quantitative. Reducing the risk of harm from environmental hazards and Clean and plentiful water were also more quantitative, while the remaining goal areas had

[8] Evans, E et al., (2006) *Future flood risk management in the UK.* Available at: https://www.researchgate.net/publication/239280551_Future_flood_risk_management_in_the_UK

[9] https://royalsociety.org/-/media/policy/Publications/2021/23-03-21-living-landscapes-full-report.pdf

[10] Van der Voorn, T et al., (2011) *Combining backcasting and adaptive management for climate adaptation in coastal regions: A methodology and a South African case study*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0016328711002849

fewer studies, making it more difficult to characterise the evidence base. However, based on the evidence shortlisted, it is noteworthy that only the two least covered areas, enhanced beauty, heritage and engagement with the natural environment, and minimising waste, had no quantitative studies.

Although there were more quantitative studies overall, this does not imply a greater availability of evidence – indeed a small number of data sources recurred across the study. Key sources that informed a range of studies include climate projections produced by the Intergovernmental Panel on Climate change (IPCC) and data from the UK Climate Projections produced by the Met Office.

In terms of uncertainty, the more quantitative approaches acknowledged modelling limitations and assumptions as sources of uncertainty. These were more opened ended uncertainties in comparison to uncertainties surrounding data source availability and issues of spatial resolution. Studies used various approaches to account for this uncertainty, including validating models against real-world observations and the use of error bars and sensitivity analysis. Many of the studies also called for better approaches to be developed to reduce these uncertainties in the future. Qualitative methodologies considered uncertainty as a key part of the process. For example, different levels of agreement between experts and the creation of scenario narratives would highlight and account for uncertainty.

## Process and analysis across goal areas

Looking at the methodologies applied across and within goal areas, there was a mix of methodological approaches, especially in Thriving plants and wildlife, Reducing the risks of harm from environmental hazards, Clean and plentiful water, Enhancing biosecurity and Clean air. Quantitative approaches were most common, meaning that many employed the use of modelling techniques to create projections. Many of these modelling techniques combined socio-economic inputs with different climate change scenarios, projecting what the world would look like under these different quantitative scenarios. These studies often considered adaptation strategies to reduce risks associated with environmental changes, simulating the effects and impact of these policy solutions.

The most common models in the above-mentioned goal areas were the economic and environmental ENV-Linkages and IMAGE integrated assessment models, as well as land use impact models. An interesting land use impact model projected how land sparing could potentially mitigate Greenhouse Gas (GHG) emissions from agriculture in the UK and proposed a land-sparing method. It forecasted agricultural yields, calculated future emissions, adjusted for production changes, and implemented a strategy to boost yields and diminish farmland. The freed land is then used for habitat restoration, such as forests and wet peatlands, which sequester carbon. The approach concludes by comparing 2050's net emissions against those of 1990, in line with the UK's emission reduction targets.[11]

The prevalence of economic and environmental models could be associated with the reliability on data availability. Economic and environmental data is often more readily available and easier to quantify compared to data related to political, technological or purely social factors. Incorporating a wider range of drivers beyond economic and environmental ones can increase the complexity of the modelling and many studies recognised that the limitation of current models and called for more integrated models that included both direct and indirect impacts of climate change to inform policy. Developing models which

[11] Anthony L, et al., (2016) *The potential for land sparing to offset greenhouse gas emissions from agriculture* Available at: https://www.nature.com/articles/nclimate2910

can incorporate inputs from more diverse sources could result in a more holistic understanding of how environmental futures could play out.

There were also some modelling techniques specific to the goal areas present in the shortlisted studies. These were primarily case study led and focused on a specific geographical region or species. For instance, in the Thriving plants and wildlife goal area one paper undertook a suitability analysis to predict species suitability under different climate change conditions using an ecological suitability tool, which was a model called the Ecological Site Classification system. It assessed the impact of climate change on broadleaf species suitability for timber production and was then expanded to include the UKCIP02 climate change scenarios.[12]

Although quantitative approaches did make up most of the evidence base, there were also common qualitative approaches, particularly scenario narratives. Many of the scenarios created were characterised by economic growth or technological advancements, with the aim of trying to reconcile economic growth and sustainability, often facilitated by technology. For example, Natural England carried out a scenario planning process using the ethnographic futures framework and the three horizons approach to consider a diverse set of drivers and their impact of the natural environment in England to 2060.[13] Land use change was a defining feature of all the scenarios created.

Horizon scanning, Delphi and issues papers were also common qualitative approaches. Horizon scanning was often paired with expert consultation and the Delphi method to refine issues, build scenarios and gather expert insights. As these qualitative approaches, along with scenario building, allow for incorporating a greater variety of drivers, they were seen across multiple goal areas. It is worth noting that studies that used these approaches often lacked the same depth of some of the more quantitative approaches.

As mentioned in the overview, mixed method approaches that combined qualitative foresight with forecasting were less common across all of the goal areas. One study explored a combination of backcasting and adaptive management methodology.[14] This process is useful for designing specific backcasting processes under highly uncertain climate scenarios. The authors explained that this proposed methodology is potentially valuable to policymakers and practitioners involved in climate adaptation inquiries. Another mixed approach created land use change scenarios for Europe (EU15 + Norway and Switzerland) under four different storylines. The method involved a multi-step process where, firstly, global SRES storylines were transformed into a qualitative description of relevant drivers and trends for Europe. Quantitative assessments were then made for each scenario, estimating the total area requirements for each land use type based on driver changes, using various models, expert judgment, and literature review. The authors then mapped these quantities across Europe using spatial allocation rules, prioritizes land uses hierarchically, and restricts expansion of lower priority ones. Lastly, they downscaled spatial patterns to a finer resolution using statistical techniques.[15]

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[12] Broadmeadow, M.S.J., et al., (2005) Climate change and the future for broadleaved tree species in Britain, OUP Academic. Available at: https://academic.oup.com/forestry/article/78/2/145/544784

[13] Kass, G.S., et al (2011) Securing the future of the natural environment: using scenarios to anticipate challenges to biodiversity, landscapes and public engagement with nature. Available at: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2664.2011.02055.x

[14] Van der Voorn, T et al., (2011) *Combining Backcasting and adaptive management for climate adaptation in coastal regions: A methodology and a South African case study*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0016328711002849

[15] Rounsevell, M.D.A et al., (2006) *A coherent set of future land use change scenarios for Europe.* Available at: http://macroecointern.dk/pdf-reprints/Rounsevell2006.pdf

These mixed method approaches offer a more comprehensive and nuanced understanding of what the future of the natural environment might look and can capture the strengths of both qualitative and quantitative approaches. The lack of studies that combine quantitative and qualitative methods found when conducting the present study might suggest a lack of collaboration between researchers with different skills sets. Greater availability of mixed methods future work will require more interdisciplinary collaborations, as combining foresight and forecasting often requires expertise from multiple disciplines.

# 4. Outputs and Outcomes

**Key takeaway**

Overall, the outputs of the foresight studies are broadly exploratory, showing a range of plausible future developments. There is less emphasis on mapping the impact of new policy into the future, or considering the steps that might be required to meet existing goals, which represents a significant gap in policy utility.

The availability of environmental foresight studies that make policy recommendations is limited, suggesting a need for further interpretation to identify such recommendations.

## Overview

The outputs of the shortlisted sources were broadly descriptive. Assessing the types of outputs produced by the studies against different categories of foresight detailed in the UK Government Futures toolkit[16] shows that a large majority of the studies were designed to describe what the future might be like (scenarios and visions), or to determine likely futures (through projections and modelling) – corresponding with the split in analysis described in the previous section.

- Scenario narratives outputs typically explored the implications of reconciling economic growth and environmental sustainability. They presented multiple narratives, each representing a different balance between these two objectives. These narratives aimed to stimulate discussion and encourage decision-makers to consider the potential trade-offs and synergies associated with different policy choices.
- Projections often depicted future outcomes under different climate scenarios, assuming the continuation of current policies and management strategies. This was used to highlight the success or failure of present strategies and suggest which policies were suitable for the future management of the environment. There were also more general projections of the future under different climate change scenarios or socio-economic pathways.

There was evidence of some horizon scanning outputs, which seek to gather intelligence about the future, but there were far fewer studies that produced outputs designed to explore the dynamics of change, develop and test policy and strategy, or rate how likely it is that future goals will be met.

Despite the prevalence of both projections and scenario narratives, relatively few studies explicitly linked the quantitative projections with the qualitative scenario development. This arguably disconnect limits the ability to fully integrate the insights gained from each approach and hinders the development of comprehensive strategies that address both the quantitative and qualitative aspects of environmental futures. Limited understanding of potential trade-offs and synergies associated with different policy choices can result in fragmented planning and decision-making, where different aspects of environmental futures are addressed in isolation.

[16] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/674209/futures-toolkit-edition-1.pdf *this work for the OEP was conducted prior to the publication of the of the 2023 update of The GO Science Futures Toolkit.*

Our interpretation is that without a clear understanding of the potential trade-offs and synergies associated with different policy choices, it is difficult to design and implement effective policy interventions. This can lead to policies that are either too ambitious or too conservative and may not achieve the desired outcomes. The disconnect between quantitative projections and qualitative scenario development limits the ability to learn from past experiences and adapt strategies accordingly. Without a clear understanding of the relationship between quantitative projections and qualitative outputs, it is difficult to identify the factors that contribute to successful or unsuccessful outcomes and adapt future strategies.

The outcomes of the studies – recommendations for action, new policy or suggestions of how to reach identified future states – were frequently weak. Often this was because they were mechanisms to inform policy-making rather than being policy-making functions themselves and therefore offered broad unmeasurable suggestions. Some outcomes were highly specialised to one scientific area. One common recommendation was for further research to build understanding about the complex interactions of different drivers identified.

Within the more quantified areas of study, it was often recommended that existing models could be integrated with more data sources, or for enhanced spatial resolution (especially in climate models), to include more direct and indirect impacts of climate change. This would serve to reduce the level of 'knowable' uncertainty that was the primary preoccupation of these types of paper. Qualitative and foresight-led papers that focussed on open-ended uncertainties from wildcard events and unexpected consequences of drivers and policies tended to recommend the need to take a proactive, adaptive, and integrated approach. Regular updating of driver assessments and horizon scans to keep abreast of issues and monitor existing ones were also recommended.

Another recurring conclusion that the studies made was the need for greater multi-disciplinary stakeholder engagement on environmental issues. This emphasis stems from the highly interconnected nature of environmental challenges, which require a comprehensive understanding of diverse perspectives and expertise.

Some studies provided more concrete outcomes. For instance, those which analysed the impact of different adaptation and mitigation strategies into the future were able to show the benefits for each and therefore recommend which ones should be integrated into policy.[17]

Many studies concluded with statements asserting the value of their findings for informing policy decisions. However, our research also shows that there is a disconnect between the foresight evidence produced and the needs of policymakers. Insight from stakeholder interviews conducted as part of this project found that many foresight and forecasting reports remained too abstract and lacking in actionable recommendations. More effort is required to develop reports to be more policy ready, providing support and creating clearer recommendations that time poor policymakers could use more easily.

Policymakers often face time constraints and may not have the necessary background knowledge to effectively utilize research evidence. To bridge this gap, environmental futures work needs to develop

[17] Moor, H et al., (2022) *Rebuilding green infrastructure in boreal production forest given future global wood demand.* Available at: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.14175

more policy-ready outcomes, providing clear and concise recommendations that can be easily understood and applied by decision-makers.

This gap between research and policy is not unique to the field of environmental futures. Similar challenges have been observed in other areas, highlighting the need for effective mechanisms to translate evidence into actionable policy recommendation. Think tanks and other organizations can play a crucial role in this process by synthesizing research findings and developing practical recommendations that can inform policy development.

## Outputs and outcomes across goal areas

In line with the overview story, scenarios and projections were the most common output across all of the goal areas.

Thriving plants and wildlife was found to be the most balanced goal area in terms of outputs, having an almost even split between scenarios and projections outputs. Many of the outputs in this goal areas focused on single species or small areas of the UK. Only a few had a wider remit and just one, an Environmental Outlook published by the OECD, covered wider projections for biodiversity alongside other factors like climate change, air quality and waste.[18] Nitrogen deposition analyses were also used to project the level of threat this poses to plant biodiversity. Other studies generated projections of the impact of increased demand for forest products and wood energy on carbon sequestration and biodiversity.

Common outcomes associated with Thriving plants and wildlife goal area were action calls for more habitat creation strategies and the implementation of more policies to support plants and wildlife. The importance of addressing nitrogen emissions through agriculture technology and habitat management was also highlighted.

Projections were also the most common output in Reducing the risks of harm from environmental hazards and Clean and plentiful water goal areas. These two significantly rely on projections in comparison to other goal areas, suggesting that these goal areas rely more on quantitative data to understand the future.

Scenarios, both qualitative and quantitative, predominated in Using resources from nature more sustainably goal area, which speaks to the broader focus of this goal area. Scenarios, especially qualitative ones, allow for accounting for a wider range of drivers, making it a suitable methodology for this goal area.

In Mitigating and adapting to climate change goal area, the rising risk of floods and the importance of peatland conservation were highlighted outputs. High economic growth and emissions scenarios predict a substantial increase in flood risk, while sustainability-focused scenarios show less severe increases. Coastal flooding risk is also expected to rise notably. Peatland carbon sinks are explored, with temperature and moisture identified as key drivers affecting peatland carbon stocks. Many studies in this goal area placed an emphasis on sustainable practices in fisheries, forest management and

[18] https://www.oecd.org/environment/indicators-modelling-outlooks/oecd-environmental-outlook-1999155x.htm

infrastructure development as well as stressing the importance of reskilling the workforce for societal changes toward net zero.

Multiple emission reduction projections are explored in the Clean air goal area, such as nitrogen emissions and their effect on biodiversity. Projections of nitrogen emission highlight that reductions are unlikely to restore plant biodiversity to historical levels by 2030, indicating ongoing threats to ecosystems. Other emission reductions include particulate matter (PM) 2.5 reductions. Scenarios that modelled different levels of ambition for PM2.5 emission reductions suggest possible health and environmental benefits from aggressive policy actions.[19] Outcomes in this goal area highlighted the need for air pollution models to be refined, especially for $NO_2$ predictions.

The Minimising waste goal area outputs focused on the specific issues of waste and nuclear safety. Projections found that if current trends continue without new policies, waste generation may increase. However, the shortlisted sources suggest that more sustainable lifestyles could stabilize or reduce waste. Common outcomes in this goal area the recommendation for greater advocacy for international cooperation for safe nuclear decommissioning to avoid negative environmental or health effects.

As well as goal-specific outputs and outcomes, the analysis of shortlisted sources showed that there are also commonalities in terms of what the outputs say about how the environment of the future will look across goal areas. Many of the projections warn of substantial biodiversity loss due to climate and land-use changes. One source forecasted substantial biodiversity loss by 2070 due to climate and land-use changes, with implications for ecosystem functionality.[20] The importance of sustainable land use is also highlighted by projections and scenarios.

Outputs across goal areas also suggest a general decline in agricultural land used for food production and an increase in land for bioenergy crops, with socio-economic factors being found to heavily influence land use changes. Several shortlisted studies highlighted that there would be future challenges related to balancing demand and supply, ensuring stability in food supplies, and managing food system contributions to climate change mitigation. Through the use of scenarios, studies indicated that dietary change, crop yield improvements, afforestation, peatland restoration, and technological advancements can significantly reduce emissions and increase resilience in land management against climate change impacts and improve food security.

Integrated land and water management also came out as a top priority for the future, especially in the Clean and plentiful water goal area, where studies recognised the water and land interdependency. The importance of the restoration of natural habitats, and efficient agricultural practices was also stressed.

[19] ApSimon, H et al., (2023) *Integrated Assessment Modelling of Future Air Quality in the UK to 2050 and Synergies with Net-Zero Strategies* Available at: https://www.mdpi.com/2073-4433/14/3/525

[20] Newbold, T. (2018) *Future effects of climate and land-use change on terrestrial vertebrate community diversity under different scenarios* Available at: https://discovery.ucl.ac.uk/id/eprint/10050238/68/Newbold%20_Future%20effects%20of%20climate%20and%20land-use%20change%20on%20terrestrial%20vertebrate%20community%20diversity%20under%20different%20scenarios_VoR%20(1).pdf

# 5. Analysis of goal interdependencies

**Key takeaway**

The foresight and forecasting studies examined in detail demonstrate that interdependencies between EIP goal areas are considered (and account for just under half of this sample). This suggests that OEP should avoid a 'siloed' approach to futures-related work and pay particular attention to the interrelationships between different goal areas and the implications for policy and accountability.

Given the importance of the interrelationships between goal areas to OEP's mission, we carried out a simple quantitative assessment of the nature and the extent of the goal interdependencies captured in the documents we reviewed. This was informed by the coding conducted for each document, which identified the EIP goal areas it addressed. This means that if we used a particular search term (e.g. for Clean and plentiful water) and that document also addressed Thriving plants and wildlife then we recorded both EIP goal areas as issues addressed in that document. This characterisation allowed us to provide a picture of these crosscuts between the EIP goal. The table below provides details of the extent to which the 88 studies analysed addressed single or multiple EIP goal areas. Just over half addressed a single goal area, and just under half addressed multiple goal areas. Of the latter group, 27% addressed two goal areas and just under 15% three goal areas. Very few studies addressed more than four goal areas.

**Table 1: Summary of EIP goal areas coverage**

| EIP Goal Areas | | |
|---|---|---|
| 1 allocation | 45 | 51.1% |
| 2 allocations | 24 | 27.3% |
| 3 allocations | 13 | 14.8% |
| 4 allocations | 4 | 4.5% |
| 5 allocations | 1 | 1.1% |
| 6 allocations | 0 | 0.0% |
| 7 allocations | 0 | 0.0% |
| 8 allocations | 1 | 1.1% |
| 9 allocations | 0 | 0.0% |
| 10 allocations | 0 | 0.0% |
| **TOTAL** | **88** | **100.0%** |

Source: Ipsos analysis

The finding that around half of the studies examined addressed more than one EIP goal area is of policy significance because it tells us that there are inter-dependencies between these goal areas that may require consideration by the policy community. Consequently, we took a more detailed look at these goal area inter-dependencies. This involved examining the patterns in multiple goal area relevance, patterns that are summarised in the following triangular matrix (that has been 'heat mapped' to highlight the stronger positive and negative associations between goal areas).

The matrix reports the correlations between the goal areas across the set of studies we examined. The Annex contains the full EIP goal relevance allocation table from which these correlations were calculated. When interpreting this correlation matrix, it is important to bear in mind that this is only a rough analysis of complex patterns from a limited sample of studies and therefore will not reflect the real broader patterns of such interdependencies. They have been highlighted simply in order to stress the importance of this issue to OEP's mission.

The main purpose of presenting these indicative findings is to draw attention to the importance of examining these goal area inter-dependencies, in greater detail in future work – ideally using a far broader set of foresight and forecasting studies (88 is a small number of studies).[21]

These inter-dependencies, especially if they are mapped more comprehensively in any follow-up work of this type, should be interpreted as demonstrating the advantages of 'de-siloed'/whole-of-government policy stances. As we stressed in the introduction, holding government to account should involve considering the ways in which addressing environmental challenges requires a consideration of how the focus of environmental work by one department can also affect that of another department. The table below draws attention to these aspects by revealing the 'proximity' between the environmental issues addressed. One potential future use of this type of inter-dependency mapping would be to use it the 'bundle' together aspects of environmental futures that lie within discrete departmental/agency responsibilities and those that bridge these responsibilities, and therefore require a more coordinated approach.

This assessment of the EIP goal area inter-dependencies tells us that there are the expected associations between Clean and plentiful water and Reduced risk of harm from environmental hazards, and between Clean air and Managing exposure to chemicals and pesticides. The main conclusion to draw from this analysis is that it is unwise to assume that foresight and forecasting studies are limited to a primary EIP goal area – nearly half of those examined addressed more than one goal area. This finding supports the points made in the introduction regarding the importance of considering the inter-dependencies between goal areas in OEP's mission to hold government to account. We return to this point in the Implications section.

[21] Note: negative correlations in this matrix indicate that the EIP goal patterns are inversely associated with each other rather than positively associated with each other.

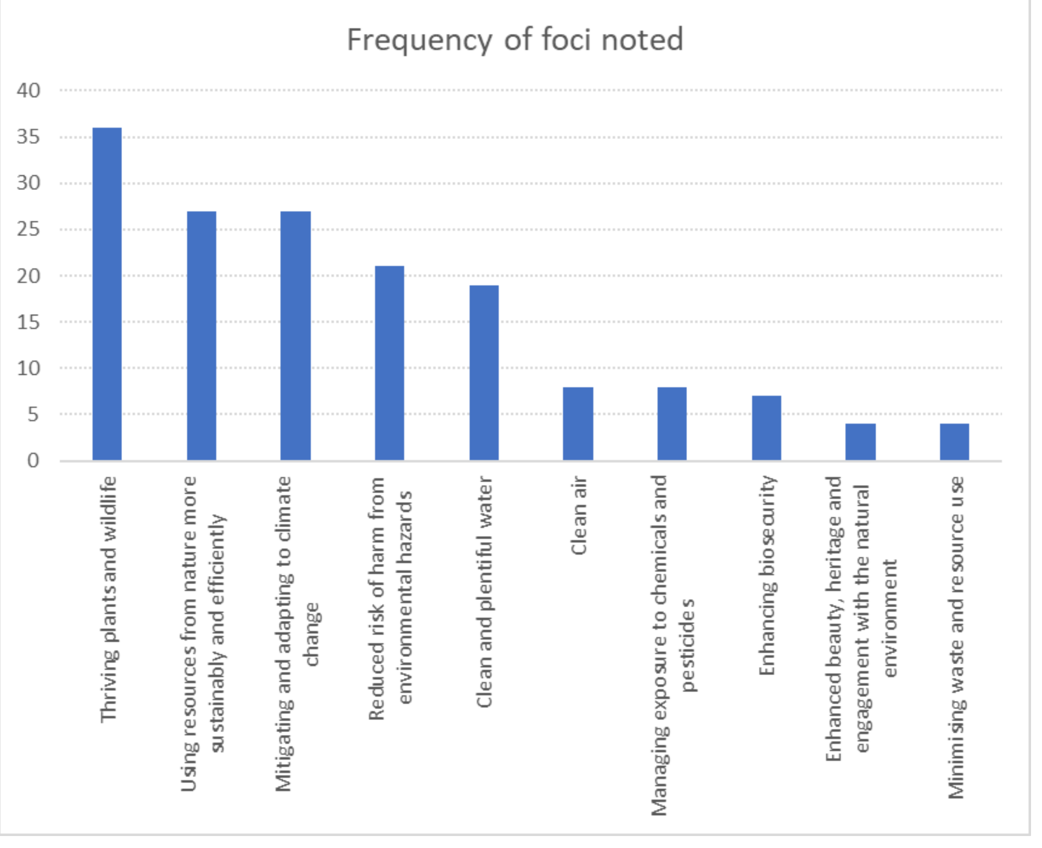
**Table 2: EIP Goal area correlation matrix**

| EIP Goal Area correlations noted in the studies | Clean air | Clean and plentiful water | Thriving plants and wildlife | Reduced risk of harm from environmental hazards | Using resources from nature more sustainably and efficiently | Enhanced beauty, heritage and engagement with the natural environment | Mitigating and adapting to climate change | Minimising waste and resource use | Managing exposure to chemicals and pesticides | Enhancing biosecurity |
|---|---|---|---|---|---|---|---|---|---|---|
| Clean air | | 0.03 | 0.14 | -0.08 | -0.12 | 0.12 | 0.05 | 0.12 | 0.31 | 0.05 |
| Clean and plentiful water | | | 0.01 | 0.35 | -0.29 | -0.11 | -0.17 | 0.15 | 0.03 | -0.15 |
| Thriving plants and wildlife | | | | -0.19 | 0.00 | 0.15 | 0.20 | 0.04 | 0.14 | -0.16 |
| Reduced risk of harm from environmental hazards | | | | | -0.20 | 0.01 | -0.08 | -0.12 | -0.08 | -0.07 |
| Using resources from nature more sustainably and efficiently | | | | | | -0.03 | 0.20 | -0.15 | 0.13 | -0.01 |
| Enhanced beauty, heritage and engagement with the natural environment | | | | | | | -0.03 | -0.05 | 0.12 | 0.14 |
| Mitigating and adapting to climate change | | | | | | | | -0.03 | -0.12 | -0.01 |
| Minimising waste and resource use | | | | | | | | | 0.12 | -0.06 |
| Managing exposure to chemicals and pesticides | | | | | | | | | | 0.05 |
| Enhancing biosecurity | | | | | | | | | | |

Source: Ipsos analysis

Finally, the chart below shows the frequency of EIP goals noted when all 88 studies are analysed. However, as with all of this assessment, sample selection bias can drive the findings. It is therefore important to consider solutions to reducing this sample bias by allowing for a larger number of studies to be analysed using semi-automated AI tools. This brief analysis of the inter-dependencies between goal areas demonstrates one aspect of how AI tools could be used at a much larger scale to identify patterns in futures-oriented studies.

**Figure 3: Frequency of focus of studies**




Source: Ipsos analysis

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# 6. Implications for the OEP

As well as summarising the key recommendations from the evidence based, the core Ipsos team presented the interim results of the environmental foresight evidence review to the Ipsos Advisory board. Below we outline the key recommendations arising from this work, denoting whether the recommendation emerged from the evidence review or the input of the Advisory Board.

## Key findings for OEP's mission

Holding government to account in an environmental management context involves assessing the extent to which the messages and insights from foresight and forecasting studies are being recognised and acted upon by relevant departments and agencies. From an uncertainty and risk management, and a related preparedness and resilience perspective, this means being able to identify opportunities and threats that may require more attention than at present, and (potentially) re-directing attention to new opportunities and threats and away from older concerns that may, now, be of a lower priority.

In this decision-based context, the studies assessed tell us the following:

1. Foresight and forecasting studies rarely directly address the policy implications of their findings and conclusions. This means that additional work is required to act as the bridge between foresight and forecasting studies and OEP's core concerns. This analysis stage will tend to be point at which quantitative and qualitative evidence are brought together to consider how attractive and feasible different policy actions and responses are. This function can be provided by a mix of internal OEP and external commissioned 'translation' work to convert foresight and forecasting findings into policy implications.[22]

2. If this policy translation bridge is not effective then the OEP is not as well-positioned as it could be to maximise the value it obtains from foresight and forecasting studies. Information is available but can be hard to act upon without a policy translation bridge.

3. Uncertainties are an inevitable feature of futures-oriented work, and inevitably limit and cause risks in policymaking. For this reason, adaptive learning-based policy approaches in which the existence of uncertainties is less problematic are used in environmental areas (e.g., flood management). It would therefore be useful for OEP to consider adaptive management capability when assessing departmental and agency performance.

4. Foresight and forecasting studies can address multiple EIP goal areas – not just a single goal area of interest, this reflects the important inter-dependencies between different EIP goal areas. Consequently, it is important to keep track of, and use, these inter-dependencies.

5. Finally, there is the problem of selection bias and its consequences noted in the introduction, and inherent in the studies covered by this project. The significant limited (human) resources required to read and analyse convert foresight and forecasting studies creates a risk of overlooking useful

[22] Note: this is a familiar challenge in clinical/medical research reporting and some medical journals now require an article to include a set of pragmatic implications of the research findings for day-to-day clinical practice (these implications and excluded from the journal's peer-reviewing process).

evidence and insights relevant to environmental policymaking. Consequently, it is useful to explore the potential to apply modern AI tools to semi-automate literature review, in so doing allowing a far larger number of studies to be analysed.

## Recommendations for the future of the OEP

### Recommendation theme 1: Further focus on discovery

The shortlist was felt to provide a clear understanding of the publicly-available studies that exist in environmental foresight. However, it is clear too that the picture is partial. Some goal areas have far fewer studies than others: in some cases, this is because it is very tightly defined and quantitative in nature (for instance, Clean air). Others may be under-researched or have key evidence or data sources which are not publicly available. It is also the case that more operational day to day and current issues like waste management are less likely to be the focus of future based work than climate change, which until recently has been seen as very much a future issue.

The Advisory Board workshop members echoed comments from the stakeholder interviews conducted earlier in the project by reflecting that they felt more studies and evidence might exist in less accessible formats and locations. The nature of government foresight teams, who tend to be small and embedded across different government departments, arms-length bodies and agencies, means that information sharing can be difficult.

This creates a challenge for further attempts of studies as well as finding data sources that might support further foresight and forecasting. Discovery efforts should focus as much, if not more, on building relationships across organisations, rather than improving search approaches. Examples of activities include:

- **Recommendation 1.1**: Mapping existing studies more thoroughly through a call for evidence. This call should differentiate between foresight studies (reports and publications, which have been the basis of this project) and data and evidence that can be used for foresight (e.g. climate projections) to gain a better understanding of the weight of evidence in a given area and how many reports this data informs. The call should also consider grey literature as there is a broad base of future environmental work that has not been published. The shortlist is a clear start point from which further studies and evidence can be requested. It is clear that no single organisation understands the totality of foresight evidence around the natural world and this is a gap that the OEP could meet.

- **Recommendation 1.2**: Focussed foresight research should be carried out in some of areas where there are fewer studies. However, this should be conducted after there has been a further call for evidence so duplication can be avoided and work can be focussed on truly less well-studied areas and connect with existing sources of evidence and themes.

- **Recommendation 1.3**: Organising or convening roundtable-type events for foresight and forecasting practitioners within government and further afield to meet and share information and studies on the goal areas relevant to OEP would meet a gap and bring together practitioners from different future-facing disciplines to share insights and collaborate.

- **Recommendation 1.4**: Map potential demand for futures insights within the policy community. The OEP should not only explore the availability of environmental foresight work, but also understand what the demand for this type of work currently exists.

### Recommendation theme 2: Approaches to Horizon scanning

As seen in the evidence review, the Advisory board noted that there was less focus on horizon scanning and issues papers than other descriptive foresight and forecasting methods, although often a horizon scan precedes and is built into scenario generation.

Horizon scanning was felt to be an important precursor to many different types of foresight study; primarily it helps to keep abreast of what is being published across government on the topic and would support a convening role for OEP in future.

The approach to horizon scanning should also be multilayered, looking beyond existing social and demographic factors which are commonly held to be the drivers of change in society. Horizon scanning methodologies should derive potential insights from the top down (driven by global macro forces), the middle out (from developments in culture, opinions, attitudes and values), and the bottom up (new innovations and behaviours by individuals that could accumulate over time and cause systemic change).

Capturing weak signals (subtle signs of emerging issues with significant impact potential) from bottom-up signals of change would be a particularly valuable exercise: building from experiences in national security, horizon scanning can play a more active role by focussing on "weak signals" of future negative scenarios and presenting these to policy makers.

- **Recommendation 2.1**: Conduct regular horizon scanning of new publications and grey literature from government organisations and others in each goal area, with an emphasis on broadening the scope to connect with experts in different disciplines. This could happen on a 6 monthly basis.

- **Recommendation 2.2:** Ensure horizon scanning is open and provocative, highlighting potential "wildcards" or strongly negative events projected from current trends (e.g. population collapse in keystone species). This can be used to prompt policymakers to consider how they could react, or what would need to change to guard against this outcome becoming more likely.

### Recommendation theme 3: Publicising exploratory scenarios to promote behaviour change

Another reflection from the Advisory Board is built on the reflection that many studies in the shortlist do not consider how the outputs could be used to influence and shape future policy, or the impact of suggested policies on future goal pathways.

As we note in the fourth and final recommendation, scenarios that draw on both quantitative and qualitative data can provide a stronger basis to support policy recommendations. Another point is that compelling scenarios may also be able to drive change in public behaviour – but this self-reflective impact is hard to model. Government produced quantitative scenarios of the ways land use might need to change to meet its biodiversity targets in 2042, but these could be brought into public consciousness through more descriptive outputs that consider how life might look in each of these futures.

Raising awareness of what the future could look like on current trends – and the likely negative consequences – could rally policymakers and the public to take further action. As a statutory body with a clearly defined mandate to report to Parliament, OEP may have greater influence than other organisations.

- **Recommendation 3.1**: Generate scenarios of the future of the natural world in England and Northern Island based around long-term targets in the Environment Act that consider the types of policies required across different goal areas and model their impact.

- **Recommendation 3.2**: Publicise more descriptive scenarios to influence government and the wider population, including positive visions of the future as well as clear negative scenarios and outcomes that may influence behaviour.

This recommendation is particularly important because widely disseminating information on the potential future consequences of decisions made by the population in the present can drive behavioural changes and policy/regulatory change that, in turn, change the odds of different future scenarios eventuating. Disseminating information of this type can also help to reduce social myopia over the future (in economic terms the Social Rate of Time Discounting) leading to behavioural changes that do more to factor-in the long-term future consequences of current decisions. These types of futures-induced behavioural changes can either complement and reinforce public policy, or, less helpfully confound and limit the efficacy of public policy.

Given this important impact pathway, descriptive future scenarios are most ‘change generating’ when they set-out key aspects of the links between potential futures (wanted and unwanted) and current decisions. It would therefore be helpful if all future scenarios contained this ‘link to the future’ element. The more easily grasped this link between current decisions and future scenarios the greater the likelihood of inducing useful mass behavioural changes that make the challenges for public policy easier rather than harder to address.[23]

### Recommendation theme 4: Greater focus on reflexive futures - backcasting and policy testing

A final implication of the nature of the shortlist is that a large majority of studies are descriptive, outlining potential scenarios but not connecting this with the policy steps needed to make some scenarios more likely, while preventing others from occurring. There is a need for more foresight studies which connect visions of the future with clear policy steps – a point raised in both the advisory group and the interviews with policy stakeholders as a weakness of most foresight studies.

Studies that connect scenarios and policy typically use both qualitative and quantitative data; scenarios might be generated through qualitative and workshop processes, but they need to be connected to quantitative modelling to give a clearer indication of the potential impacts of policies which will have cut-through with decisionmakers. This type of work also tends to focus on “missions” or cross-cutting themes that unite structures like goal areas.

- **Recommendation 4.1**: The OEP could conduct some backcasting work which would start with creating preferable visions of the future of the environment where the EIP goals are realised. Then, they would work backward to explore which policy actions the government should be taking now to make this future happen. This backcasting approach would be improved if a grand strategy existed since that provides the overarching framework helping to guide policy decisions, and helps to de-silo thinking.

[23] https://marklmatthews.files.wordpress.com/2014/02/second-preparedness-paper.pdf

- **Recommendation 4.2:** OEP could define some cross-cutting themes or missions to their work which could help be a basis for future policy. Biodiversity is one clear example as it has connections across Clean air and water, climate change, use of landscape for food and recreation, and many of the other domains covered by the goal areas.

- **Recommendation 4.3**: OEP could conduct more work that directly considers how different policies could impact mission areas such as biodiversity through qualitative and quantitative analysis. This could be through projecting future states based on qualitative scenario generation or taking quantitative projections and building future scenarios around them through a participatory or stakeholder-led process.

### Further considerations for the OEP

This study allows us to suggest the following recommendations beyond the main focus of this work:

1. If the OEP commissions any foresight and forecasting studies directly, this should emulate the modern medical journal approach and specify that any policy implications be noted at the end of the report.

2. OEP could liaise with research councils, departments and agencies, and think-tanks NGOs to increase the emphasis on noting any policy implications – as this may not naturally be done by all authors (especially academics).

3. OEP could assess the current effectiveness of internal analytical capability to deliver a policy translation bridge linking foresight and forecasting studies more effectively with OEP's mission.

4. OEP should consider encouraging a closer examination of goal area inter-dependencies by foresight and forecasting study funders (especially research councils and other departments and agencies).

5. OEP should consider mapping the key goal area inter-dependencies that shape environmental futures against departmental responsibilities, with the aim of identifying any gaps that fall between these responsibilities. This gap analysis will be important in holding government to account from a 'joined-up' perspective.

6. It may be worth the OEP learning from more comprehensive and integrated 'grand strategy' approaches in this context.

7. Given the risks of sample selection biases and gaps in analysing foresight and forecasting studies, it is worth the OEP exploring the use of AI to assist in such work, allowing a far larger number of studies to be examined. There are currently limited (commercially provided) AI solutions optimised for futures work, but these are worth exploring as a means of reducing sample selection biases (in particular the problems faced in examining a limited short list of studies within potentially extensive long lists). A feasible target using modern AI tools is that no short list is needed as systems able to extract information at large scale and high speed are now becoming available.

# Appendix 1: Scoping interviews summary note

This appendix outlines the key findings from the interviews which were completed at the beginning of the project with environmental foresight and forecasting experts who helped to scope the project.

## Background and methodology

Ipsos conducted seven thirty-minute interviews in July 2023 with foresight and forecasting experts from environmental Government bodies and charities during the first stage of the environmental foresight review project. The purpose of the interviews was to understand stakeholders' views of the strengths and limitations of environmental foresight, uncover new sources that could be included in the evidence longlist, and explore the role OEP could play in environmental foresight in the UK.

Participants were from different public and third-sector organisations involved in environmental policy. Some were directly involved in conducting foresight while others used other future-facing methodologies such as forecasting and modelling, or used these approaches in their work. Each interview covered their experiences of how foresight was used within their organisation, a discussion on the data sources they use in foresight, and the role they saw for the OEP operating in this space in future.

This document is a summary report of the key takeaways Ipsos has gathered from the interviews, which was taken forward to inform the later synthesis stages of the project.

## Organisational approaches to foresight

### Key takeaways

- **Foresight teams are usually small**, and tend to be based outside organisational structures or siloes. They appear to face challenges in securing input from subject specialists.
- Foresight work appears to consist mainly of **'set pieces'** – big reports that happen on long cycles – or documents and evidence that is not published. This makes relationships between organisations and individuals especially valuable.
- **Foresight practitioners tend not to have forecasting expertise – and vice versa**. This reflects strongly contrasting data availability and approaches to uncertainty in specific environmental domains.
- Challenges around **how to activate foresight** were common – this was tied to quantitative modes of knowledge having greater impact in decision-making, and policy-making in particular.
- **It was felt that environmental science and foresight receives limited funding overall**, with the bulk coming from Government sources. This was seen as part of the explanation for limited data availability.

Reflections from across the public sector foresight experts interviewed revealed that foresight teams tend to be small, typically with a single-digit headcount. Often these professionals sat outside the main structures of their organisation, which tended to have a delivery focus. While this enabled them to speak to people across divisions, some mentioned that obtaining cooperation from subject matter experts within their organisation could be challenging because those experts did not see contributing to foresight as part of their role, or something they had been requested by Government to participate in.

> "The reason why the [subject] experts do not get involved is because they are not asked by the government. These committees [which involve the subject experts] have their agendas set by mid-level busy Civil Service members who have a lot of problems to sort in the short term."

Foresight practitioners reported engaging in two main types of work – horizon scanning (finding and collating short-term 'signals' of the changing operating environment for their organisation or sector) and much longer-term scenarios or "state of the sector" work with multi-year horizons, such as Natural Resources Wales' SoNaRR, the RSPB's State of Nature report, or the European Environment Agency's SOER reports. Both types of work pose challenges to external evidence reviews and sharing of information: the former is internally-focussed and often too specific to have wider applicability, while the latter is published infrequently, meaning there are long periods of time between publications where the available evidence is dated (for instance, the most recent SOER is from 2020, so pre-dates the COVID-19 pandemic).

Other participants were forecasting or modelling professionals rather than foresight practitioners. By contrast with foresight experts, their expertise was more closely focussed in areas such as air quality and climate change where there are significant quantitative data resources. The skillsets of foresight and forecasting practitioners appeared to be very different and there was very limited overlap in competence between the two groups in the interviews that were conducted.

Those in foresight reported experiencing some challenges in working with scientific experts, especially in qualitative foresight and scenarios – although they felt that this input was very important for their work. From foresight experts' perspectives, scientific thinkers found it harder to engage with the systemic issues that cross disciplines that tend to be the focus of foresight. There were also challenges around thinking over different timeframes, especially mid-term futures: those from a scientific background were often considered to be very certain about the near-term future, and confident talking about the longer term (e.g. out to 2050) where data existed and could be projected. But they were seen as less able to engage with mid-term discussions about pathways between the present and a desired future state without significant facilitation.

> "What I do find challenging with scientists is their lack of imagination about the future… Their ability to escape the present is difficult. That's where the mental scaffolding you're putting up front really matters."

Another reflection from foresight practitioners as well as others was on challenges in getting others to use foresight outputs in decision-making. Although there was less comment on why this was a challenge, it was noted across different participants and was a strong theme in the analysis. This perspective was repeated by a participant from environmental policy, who found that qualitative foresight lacked cut-through for policymakers. In areas such as biodiversity, their preference was for figures to demonstrate likely futures, even if the basis on which the figures were produced was methodologically weak.

> "It does often come back to answering not just that 'So what' question, but that, 'So what now' question. 'What is it we do now? What is it we do tomorrow that's different to what we did last week?'"

> "When you say 'vision', it seems to be an excuse to deal in cotton wool."

A final reflection, which ties into the discussion of data and information sources, was a note that there is limited funding for environmental science compared with other areas of research – and that environmental foresight garnered less funding and attention still within this sector. One result (although this may reflect the position of participants) was that the Government and its agencies is usually the sole funder of research in this area. Unlike health or development, and despite there being a number of well-known global charities operating in this area, there appear to be no significant independent funders of research or foresight into the environment.

> "The environment sector doesn't have the equivalent of the Wellcome Trust or Bill and Melinda Gates Foundation; it is only really the state who is the funder."

## Data sources and methodologies

### Key takeaways

- **Foresight tends to rely on mixed methods**, or qualitative data collection. But methods vary between different issues and over different timeframes.
- There are **relatively few high-quality or well-known quantitative data sources** in environmental foresight, and these can be found in just a few areas under the OEP's remit. These data sources feature in a significant number of the foresight and forecasting projects that exist.
- Some expressed **scepticism about the quality of the quantitative data and models that exist**, especially in biodiversity. It was felt that the change in values recorded by these sources was more useful than the absolute values they showed.
- Yet for those working to influence policy, **quantitative data and trends** were seen as more influential and useful.

Foresight participants used a range of qualitative and quantitative data in their work and felt that a mixed-method approach was most suitable for long-term thinking, although the balance of methods varied across different focus areas. Typically, they saw quantitative data as too simplistic to be used to project into the future, especially in areas where there is a high level of complexity, such as food, agriculture and water. Rather it was seen as one input of many to influence qualitative work where divergent scenarios for the future could be developed.

By contrast, forecasters tended not to focus on qualitative data and used alternative projections to create different scenarios and reflect uncertainty. However, this approach was based in specific areas such as flood risk and climate change where there is sufficient data. In others, such as marine science, the available data was far too limited to be of use.

> "The further out you look with the code of uncertainties, the more your errors are going to grow, and [quantitative] modelling becomes less and less useful."

> "When doing mitigation [work] we deal with quantitative [methods]… The difference between mitigation and adaptation is that with mitigation you have a clear target."

The relative scarcity of data for environmental foresight was another key theme that emerged from the interviews. Across different areas, foresight and forecasting experts tended to rely on the same few data sources: for instance, IPCC and CCC models in climate change and flood risk modelling in environmental hazards. Other documents and sources (as noted previously) are not always public and held internally, or published on longer-term cycles. This means that the amount of current and published foresight in many areas is a small proportion of the overall volume: in this context, building relationships with other public bodies and organisations is an important part of understanding the wider picture.

The paucity of sources also poses difficulties for the impact of foresight. In an interview with an expert who used foresight and forecasting to lobby for policy change, there was no doubt that being able to present statistics or projections was more effective than presenting qualitative scenarios or other outputs.

> "Qualitative work is useful for public audiences and individual politicians who want a lyrical narrative. [However], it would be nice to have more command of the more detailed quantitative sources when you are making the case with the Treasury."

## OEP's role in foresight

### Key takeaways

- Across participants there was **interest in OEP assuming a role in environmental foresight**, although close collaboration would be required to ensure their contribution is additive to what is already known.
- Foresight practitioners were keen to see OEP using a **breadth of foresight methods** rather than focussing on forecasts in specific areas.
- In particular, there was a call for considering how **systems thinking could** shape OEP's work and partnerships.
- A further reflection was that OEP should **consider the theory of change/logic model underlying the EIP** that sets the terms of its work, and ensure this is updated over time.
- **Specific framings of the role OEP could take** included using foresight to highlight potential future harms to the environment and provide advice on how these can be avoided, as well as advising on the steps required to bridge the gap between the pathway required to meet Government goals and the actual trajectory observed.

Overall, there was interest in the OEP taking a more active role in foresight and extending its role into this area as it would bring more attention and funding to an area that is considered underserved. The focus was on ensuring this contribution is collaborative with existing efforts – OEP could identify government agencies and organisations operating in this area and collaborate with them. One expert explained that the value of collaboration, in the context foresight work, lies in how it allows people to have a shared and clear view of the future, making it easier for them to act effectively.

"Foresight work allows people to think systematically and to transcend interdisciplinary **boundaries. Therefore, it allows people to have a shared view of the futures landscape and to be clear on the areas of interaction and relevance that are going to have an impact. This is important because everyone needs to have the same story. If they do not it makes it harder to act effectively."**

There was also a call to reflect the systemic nature of topics such as the environment and biodiversity. Taking a systems thinking approach was brought up repeatedly; especially as it shares characteristics with foresight approaches (such as interdisciplinarity, acknowledging uncertainty).

"Systems thinking and foresight thinking, especially in environmental policy, are inherently linked because it is all about the future… The OEP could position itself to look at the EIP plan and ask is it sufficiently forward looking but is it also sufficiently systemic in what it's trying to do."

Foresight practitioners said it would be important for the OEP to be flexible and use a range of foresight methods that were appropriate to the very different contexts found within biodiversity and the natural world – often these would not include the use of quantitative datasets or approaches.

"Figure out what are the business needs for foresight and then look at the combinations of futures tools and methods that you need to achieve those business needs."

Focussing on potential roles for the OEP, it was commented that an important step in establishing a foresight function will be to assess the basis on which OEP is scrutinising public bodies – the EIP framework. The assumptions on which the 10-goal framework is based may not themselves be future-proof, which could mean that if the environmental health of the UK deteriorates further, the OEP would be scrutinising the Government against targets which are not sufficiently stretching to aid nature recovery.

"The OEP can look at the EIP itself and say "is that sufficiently informed by effective futures thinking?" and then think about what that then means for the setting of targets and achieving certain outcomes within that plan."

Some specific examples of roles for the OEP from the interviews are listed below:

- Holding a vision of what the health of the environment should look like and collating foresight evidence across the sector to identify where the country is headed.
- Using foresight to project likely future states for the environment given current policy and outline how far these are from current targets. This would allow OEP to give directive policy advice on the steps needed to bridge the gap between targets and reality.
- Instead of creating scenarios, identify key future risks or harms to the environment – for instance tipping points or species extinctions – outline how likely they are to occur and the steps that can be taken to avoid these events.

## Reflections for the OEP

These early-stage interviews outline some of the key characteristics of foresight and forecasting in the environment and the natural world, with implications for the evidence shortlisting and analysis that was conducted later in this research:

- **Foresight and forecasting are both important** in thinking about the future of the natural environment, but their data sources and areas of focus do not appear to overlap much. This means there are (at least) two types of expertise required to gain a fuller understanding of the sector – this brings challenges to an organisation trying to cover both.

- A **systemic approach is central** to effective foresight and thinking about the natural world. Uniting knowledge and evidence across diverse areas of policy and research requires deep collaboration and openness to different methods and approaches. A lesson for the shortlisting and analysis is to consider how different types of knowledge and data can be assessed and synthesised on an even footing.

- This also means that **the 10-goal EIP framework may not be the most suitable format** for projecting future environmental standards or assessing current government performance. Although visions or scenarios are not universally popular, there may be a benefit to holding a unified view of future pathways towards environmental goals which can act as a means of assessment.

- In foresight particularly, there is a low understanding of the weight of evidence that exists as much of it is infrequently published or internal. This suggests there is a high-level role for an organisation which can build relationships to **map and co-ordinate knowledge in the sector** to ensure the resources and data that exist are being used most effectively.

# Appendix 2: Foresight Goal Area focus

This appendix presents further detail on the analysis of the evidence base for six of the ten EIP goal areas. It provides information on the evidence type and methodology of the studies per each goal area, as well as the types of output and recommendation generated.

## Thriving plants and wildlife

**Overview of evidence in this goal area**

Number of sources in the shortlist: 34

Principal methodologies: 17 quantitative, nine qualitative, eight mixed-method

Principal outputs: 13 projections, modelling & pathways, 12 scenarios, visions, SWOT analyses; three 'Horizon scans, Delphi, Issues papers'

### The nature of the evidence base

Thriving plants and wildlife emerged as the goal area with the most substantial representation in the shortlisted sources, with a total of 34 sources out of the 88 long shortlist. The majority of the sources leaned towards quantitative methods, a trend that was seen across most goal areas. The remainder of the sources were evenly distributed between qualitative and mixed-method approaches, showcasing a balanced incorporation of various research strategies. The outputs generated by these sources were predominantly centred around projections and scenarios. This is unlike the Using resources from nature more sustainably and efficiently goal area, where scenarios significantly outweighed projections. A lesser, yet significant, proportion of the sources were horizon scans, Delphi studies, and issues papers.

### Inputs into environmental foresight

Common drivers in this goal areas were split into longer-term and emergent categories. Common long standing social drivers were population growth, urbanisation, and resource exploitation. Land use change was described as a significant driver of species exploitation. Key environmental driver included rising temperatures, altered rainfall patterns and increased frequency of extreme weather events. Changes to crop calendars, soil characteristics and evolving agriculture practises were also identified as key drivers affecting plants and wildlife, and some sources explored how increased $CO_2$ levels are altering ecosystems and impacting biodiversity.

Drivers which were identified as more emerging were predominantly technological, including the development of nanotechnologies, biodegradable products, and soft robotics. Each was seen as a potential benefit or opportunity that could positively influence the environment. Yet there were also new challenges, such as the invasive potential of artificial life and unintended consequences of modern biotechnology. Policy was also seen as an emerging driver for environmental foresight. Some sources referenced specific global policies and governance mechanisms, such as the Paris Agreement on Climate Change and the Convention of Biological Diversity, as legal and regulatory drivers informing their foresight work.

These emergent drivers were also seen as the source of greatest uncertainty. In particular, new policy options and changes, the feasibility and effects of large-scale atmospheric carbon dioxide removal and the capacity of species to adapt to climate and land-use changes were seen as drivers of uncertain outcomes.

### Analytical processes

Modelling is the predominant methodology for studies in this goal area, which was mainly quantitative in nature. Projections and scenarios were developed through economic and environmental models such as 'ENV-Linkages' and 'IMAGE', as well as land use impact models and climate models. Another tool used was the Sirius Crop Model that explored agricultural impacts on the environment. One source undertook a suitability analysis to predict species suitability under different climate change conditions using an ecological suitability tool, which was a model called the Ecological Site Classification system. It assessed the impact of climate change on broadleaf species suitability for timber production and was then expanded to include the UKCIP02 climate change scenarios.[24]

Uncertainty was primarily reflected in the use of confidence levels and error bars for quantitative models, alongside analyses of how changes in parameters affect model outcomes to understand the response and reliability of models. Model validation is also used through comparisons with observed data and using multiple models to estimate a range of likely impacts. Among qualitative studies, uncertainty was managed through comparing various scenarios to explore different outcomes, along with likelihood ratings to assign probabilities to the potential impacts of different drivers. Workshops and voting processes were also used to explore and acknowledge uncertainties in horizon scans and scenario development.

### Recommendations and outputs

Projections in this area were negative, stressing the deterioration of nature. Many focussed on environmental drivers of the future, signalling the impact of the effects of climate change on biodiversity, for example exploring the effects on various species under different temperature overshoot scenarios. One source forecast substantial biodiversity loss by 2070 due to climate and land-use changes, with implications for ecosystem functionality. Nitrogen Deposition analyses were also used to project the level of threat this poses to plant biodiversity and there were also projections for the impact of increased demand for forest products and wood energy on carbon sequestration and biodiversity. However, many of the projections were case study led and focussed on single species or small areas of the UK. Only a few had a wider remit and just one, an Environmental Outlook published by the OECD, covered wider projections for biodiversity alongside other factors like climate change, air quality and waste.[25]

Developing effective regulations, aligning prices with environmental costs, and fostering innovation was also seen to be vital for the future of plants and wildlife. However, only some sources made policy recommendations, exploring how different policy measures could improve ecosystem services into the future and how habitat creation strategies can aid species in fragmented landscapes. For instance, one study explored habitat restoration in fragmented UK landscapes, using a model to evaluate the effectiveness of six different habitat creation strategies.[26]

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[24] Broadmeadow, M.S.J., et al., (2005) Climate change and the future for broadleaved tree species in Britain, OUP Academic. Available at: https://academic.oup.com/forestry/article/78/2/145/544784

[25] https://www.oecd.org/environment/indicators-modelling-outlooks/oecd-environmental-outlook-1999155x.htm

[26] Hodgson, J. A., et al., (2011) *Habitat re-creation strategies for promoting adaptation of species to climate change*. Available at: https://conbio.onlinelibrary.wiley.com/doi/full/10.1111/j.1755-263X.2011.00177.x

Ultimately, many of the recommendations from the studies in this evidence base focussed on method, further research and the implementation of more strategies to support plants and wildlife. Some called for more integrated models to assess the impacts of climate change, others suggested greater use of more adaptive strategies for land and water management to support ecosystems. Others stressed the importance of addressing nitrogen emissions through agriculture technology and habitat management.

## Using resources from nature more sustainability and efficiently

**Overview of evidence in this goal area**

Number of sources in the shortlist: 27

Principal methodologies: *11 quantitative, eight qualitative, eight mixed methods*

Principal outputs: six projections, modelling & pathways, 15 scenarios, visions, SWOT analyses; five 'Horizon scans, Delphi, Issues papers'

### The nature of the evidence base

This goal area made up a significant proportion of the shortlist, securing the second highest position with 27 sources attributed to it. As for the principal methodology employed, a large portion of the sources favoured a quantitative approach. Following this, the remaining sources were evenly separated between qualitative and mixed methods. The most prevalent outputs were scenarios, visions, and SWOT analyses, primarily qualitative in nature, with a few being driven by quantitative methods. Other common outputs included projections, modelling and pathways, and horizon scans, Delphis, and issues papers.

### Inputs into environmental foresight

The effects of climate change, land use change and urbanisation all feature again as common long-standing environmental and social drivers for this goal area. Continued negative intervention in ecosystems such as deforestation and resource exploitation are examples of this land use change. This long standing social driver is linked to the environmental drivers that were mentioned such increased wildfires and more extreme weather events. There were however positive human interventions highlighted, including geo-engineering and mitigation efforts like reforestation, while negative interventions were related to resource exploitation.

Continued negative intervention in ecosystems such as deforestation leading to environmental drivers, linked to these social drivers, that were mentioned were increased wildfires and more extreme weather events.

Drivers and trends identified as more emerging were infectious diseases and fast paced technological change, including developments in the agriculture sector. Changing food consumption trends, economic considerations like agricultural prices, market competitiveness and productivity and the regulatory landscape, including the impact of Brexit were also common trends and drivers identified as emerging drivers affecting this goal area.

These emergent drivers were also described as sources of uncertainty. Future food consumption trends, policy decisions and policies agendas were recognised to be unpredictable and therefore hard to measure the future effects of. The variability in natural processes and ecosystem responses and the complexity in the climate-land use feedback loop were also seen as sources that create uncertainty in understanding the effects of land use change.

## Analytical processes

The nature of the evidence base in this goal area is quantitatively weighted, and presented a range of different applied models, including the REGIS, CLUAM, IMAGE 2.2, CLIMAVE and GLOBIOM. In one source, the CLIMSAVE Integrated Assessment Platform provided an integrated modelling framework for multi-scenario outcomes. It was used to investigate a range of projected outcomes in the European land system across climatic and socio-economic scenarios for the 2050s. The paper that used this model acknowledges that the number of complexities and interacting effects involved in land system change makes it very difficult to achieve a complete understanding, and therefore an integrated approach is necessary.[27]

Sources based on qualitative methods used expert interviews, the Delphi method, expert workshops and axis of uncertainty for refining issues and scenario building (on occasion enhanced with systems thinking). A mixed approach that involved both qualitative and quantitative methods created land use change scenarios for Europe (EU15 + Norway and Switzerland) under four different storylines. The method involved a multi-step process where, firstly, global SRES storylines were transformed into a qualitative description of relevant drivers and trends for Europe. Secondly, quantitative assessments were made for each scenario, estimating the total area requirements for each land use type based on driver changes, using various models, expert judgment, and literature review. Next, it mapped these quantities across Europe using spatial allocation rules, prioritizes land uses hierarchically, and restricts expansion of lower priority ones. Lastly, it downscaled spatial patterns to a finer resolution using statistical techniques.[28]

To deal with uncertainty, quantitative papers used multiple models to ensure a range of future projections were explored and in most cases models were validated, often done through real world observations. For the more qualitatively led papers, diverse ranges of scenarios were explored, with uncertainty being acknowledged as a part of this exploratory approach. Likelihood levels were also assigned to drivers to indicate areas of greater uncertainty.

## Recommendations and outputs

Many of the outputs in the evidence base for this goal area related to land use, mostly focusing on the effects and dynamics of land use change. Some papers projected a general decline in agricultural land used for food production, partly offset by increased land for bioenergy crops. Continued urban expansion with different spatial patterns and retreat in coastal land areas due to policy changes and sea level rise was also projected. Identified future challenges were related to how to balance demand and supply, ensuring stability in food supplies, and managing food system contributions to climate change mitigation. Various scenarios indicated that dietary change, crop yield improvements, afforestation, peatland restoration, and technological advancements can significantly reduce emissions and increase resilience in land management against climate change impacts and improve food security. Integrated land and water management came out as a top priority for the future as well as the restoration of natural habitats, and efficient agricultural practices.

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[27] Holman, I.P a et al., (2016) *Can we be certain about future land use change in Europe? A multi-scenario, integrated-assessment analysis, Agricultural Systems*. Available at: https://www.sciencedirect.com/science/article/pii/S0308521X16302645
[28] Rounsevell, M.D.A et al., (2006) *A coherent set of future land use change scenarios for Europe.* Available at: http://macroecointern.dk/pdf-reprints/Rounsevell2006.pdf

The recommendations in the evidence base built on the outputs that centred around land use and were primarily policy focussed. Some papers promoted systemic approaches and global governance to ensure food security, biodiversity conservation, and sustainable agriculture. Many of the papers stressed that subsidies, policies, and incentives needed to be realigned to support sustainable practices and local food systems.

## Mitigating and adapting to climate change

**Overview of studies in this goal area**

Number of sources in the shortlist: 26

Principal methodologies: *11 quantitative, eight qualitative, seven mixed methods*

Most common principal output formats: ten were categorised as 'scenarios, visions and SWOT analyses, ten were 'projections, modelling & pathways' and four were 'horizon scans, Delphis and Issues papers'

### The nature of the evidence base

This goal area was the third most populated in the evidence base with 26 sources. Again, the leading methodology was quantitative, followed by eight qualitative sources and seven mixed methods sources. Scenarios and projections, modelling and pathways were the top two most common outputs with equal numbers being attributed to each method, and these were mainly quantitative in nature. Only four sources were categorised as horizon scans, Delphis and Issues papers.

### Inputs into environmental foresight

As to be expected for this goal area, many of the drivers present in the evidence base were environmental in nature. The effects of climate change feature heavily here. Issues such as sea level rise, increased precipitation, extreme weather events and temperature fluctuations are used to inform much of the foresight work in the evidence base. This goal areas, Using resources from nature more sustainably and efficiently, and Thriving plants and wildlife have significant overlap in prominent drivers and trends. Sources which explored land use were highly relevant for both. Social drivers like urbanisation, population growth, and land use management and environmental drivers such as consumption patterns and $CO_2$ removal strategies featured. Infrastructure management; for example, flood defences and warning and response systems were also important drivers considered.

Since there is significant overlap in inputs with this goal area and the previous two, the uncertainty associated with the drivers is also similar. The uncertainty surrounding the feasibility and impact of $CO_2$ removal is mentioned again in this evidence base and so are the uncertain effects of land use changes, like land sparing. Some quantitative papers mentioned challenges in projecting greenhouse gas (GHG) emissions which introduced uncertainty into some of the climate models used.

### Analytical processes

Projections were the most common method in the evidence base for this goal area. Models including REGIS and IMAGE are used to project future land use changes at different scales. For example, one paper explored projections of how land sparing could potentially mitigate GHG emissions from agriculture in the UK and proposed a land-sparing method. It forecasted agricultural yields, calculated future emissions, adjusted for production changes, and implemented a strategy to boost yields and diminish farmland. The freed land is then used for habitat restoration, such as forests and wet peatlands, which sequester carbon. The approach concludes by comparing 2050's net emissions against those of 1990, in line with the UK's emission reduction targets.[29]

Another type of methodology in the evidence base for this area was the combination of backcasting and adaptive management.[30] One paper focused on a region in South Africa and investigated how normative scenarios approaches (backcasting) can be used to develop more robust climate strategies in coastal regions. Backcasting was employed to identify a set of desirable long-term goals, allowing adaptive management to have something to work against. The authors explain that this proposed methodology is potentially valuable to policymakers and practitioners involved in climate adaptation inquiries. It is a process that is useful for designing specific backcasting processes under highly uncertain climate scenarios.

Other quantitative sources include flood risk assessments, and these take a systematic approach to calculating flood risks using data collection, impact analysis, and damage estimation. Hydrological models are also used to inform some of the foresight work in the evidence base. Particularly, PDM and Grid-to-Grid models are used to simulate rainfall-runoff processes. Peatland and agriculture projections use various methods to estimate carbon stocks and agriculture emissions. The Delphi process, scenario development and the UNEP foresight process (expert consultation) also feature as qualitative-led methods.

Uncertainty has been incorporated into the process using the same methods as the previous two goal areas. A variety of models have been used to explore a range of different outputs and error bars have been used to represent ‘uncertainty ranges’. Sensitivity analysis is used to test the robustness of model predictions against changes in input parameters, reflecting the range of possible outcomes due to uncertainties. Qualitative sources have used methods such as the exploration of multiple scenarios to account for different potential future conditions. Likelihood assessments were also used, assigning high/medium/low likelihoods to different drivers, with particular attention to those with high uncertainty of opportunity or threat.

### Recommendations and outputs

The papers that focussed on land use have similar findings to the previous goal area. They found that decreased agricultural land use for food production, increased urban areas, and forest expansion are common trends. The idea that higher agricultural yields combined with habitat restoration could significantly reduce net emissions also came up again. Socio-economic factors were found to heavily influence land use changes in the near future, with climate change effects becoming more pronounced later. Climate and land-use changes are predicted to cause substantial species loss from vertebrate communities, with significant negative effects on ecosystem functioning.

The flood risk assessment papers present a variety of different future risks. Scenarios with high economic growth and emissions predict a substantial increase in flood risk, while sustainability-focused scenarios show less severe increases. Coastal flooding risk is also expected to rise notably.

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[29] Anthony L, et al., (2016) *The potential for land sparing to offset greenhouse gas emissions from agriculture* Available at: https://www.nature.com/articles/nclimate2910

[30] Van der Voorn, T et al., (2011) *Combining Backcasting and adaptive management for climate adaptation in coastal regions: A methodology and a South African case study*. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0016328711002849

Peatland carbon sinks are also explored. Temperature and moisture are key drivers affecting peatland carbon stocks, with the potential for both gains and losses depending on future climate and land management practices.

The scenario narratives create more broad outputs about the environment, with some also incorporating policy options. Different scenarios propose various environmental futures, from enhanced ecosystem services and natural capital to loss of biodiversity and increased environmental footprint depending on socio-economic policies.

The conclusions and the recommendations that were prosed in the evidence base for this goal area were relatively specific in comparison to other goal areas. These included adapting long-term strategies and policies to address the rising flood risk and focus on water management, soil and peatland conservation, and efficient land use to mitigate climate impacts and enhance resilience. Peatland conservation was of high importance in the evidence base, with policy and management decisions being key to the future of peatlands. Other policy recommendations included emphasizing sustainable practices in fisheries and forest management and calling for infrastructure development and workforce reskilling to facilitate societal changes toward net zero.

## Clean and plentiful water

**Overview of studies in this goal area**

Number of sources in the shortlist: 18

Principal methodologies: 12 quantitative, three qualitative, three mixed-method

Principal outputs: 12 projections, modelling & pathways, two scenarios, visions, SWOT analyses; four ‘Horizon scans, Delphi, Issues papers’

### The nature of the evidence base

This goal area was the fifth most popular in the evidence base and was significantly quantitative in methodology. It was led by projections, modelling and pathways outputs. Horizon scans, Delphis and issues papers were also part of the common outputs, along with scenarios, visions and SWOT analyses, but to a lesser extent.

### Inputs into environmental foresight

Land use change features as key driver again in this goal area. In the context of Clean and plentiful water, land use changes, such as increased intensive agriculture practises are highlighted to have a big impact on water quality. Water management techniques, social drivers like population growth and urbanisation, regulatory standards, and policy frameworks are also stressed as factors that have a significant influence on the aims of this goal area.

In terms of the ‘plentiful water’, the increasing demand for water and occurrence of extreme weather events like droughts were mentioned as key drivers. Environmental drivers such as groundwater drought characteristics, seasonal changes in precipitation and potential evapotranspiration were also highlighted.

Uncertainties associated with the inputs related to data limitations. Lack of complete historical weather data and weaknesses in modelling techniques were seen as the main sources of input uncertainty.

## Analytical processes

Hydrological modelling techniques were used in the evidence base in this goal area. One paper used the CLASSIC hydrological model, driven by output from the Hadley Centre climate model (HadCM3), based on IPCC low and high $CO_2$ emission scenarios for 2080 as the basis for the analysis. The source projected how climate change and human activities might affect the flow regimes, water quality, and ecological components of two contrasting river ecosystems in England.[31] Other economic and environmental models like ENV-linkages and IMAGE feature again in this goal area.

Projections of future drought risks in England under different climate scenarios were explored in another paper using drought severity indicators, used to quantify the severity of a drought event. This source then used a Sirius crop model to evaluate the impacts of drought on wheat yields.[32]

Sources that involved qualitative methodologies included scenario analysis and workshop-based approaches. These were analyses of water quality and water management. One source was a mixed methods approach that assessed the combined impacts of multiple stressors affecting water quantity and quality, ecological status, ecological functions, and ecosystem services under contrasting scenarios. Authors conducted a workshop based on existing scenarios such as Shared Socioeconomic Pathways and the Representative Concentration Pathways. Based on these, they then created three different storylines. Using modelling tools, they quantified the storylines and ran several scenarios to predict future impacts.[33]

Uncertainty is mainly incorporated into the process using multiple quantitative scenarios and models and the effort to validate model outputs. Axis of uncertainty in qualitative scenarios were used to account for uncertainty.

## Recommendations and outputs

In terms of outputs, future drought projections for the UK indicate longer duration, particularly in the South-East, and increased intensities, especially in the South and East. One source made the connection between land and water and stressed the need for greater consideration for managing the land-water interface. It indicated that this would drastically improve the water and land-based food production systems in the UK. The same paper highlights the importance of existing regulatory frameworks, such as the Water Framework Directive (WFD), and suggests that policies must adapt to changing conditions to ensure the protection and sustainable management of river ecosystems.

The impact of the connection between social, environmental, and political drivers was also considered in the outputs. A paper that explored this connection stood up from the rest of the evidence base as this was an uncommon approach in the quantitative proportion of the whole evidence base. The local focus of this paper made it easier to analyse the dynamics between multiple sources of drivers. The study found that the growing population in the southern UK, potential climate change-induced river flow reduction, and adherence to the WFD's water quality standards may increase stress on river ecosystems

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[31] Johnson, A.C et al., (2009) *The British river of the future: How climate change and human activity might affect two contrasting river ecosystems in England* Available at: https://www.sciencedirect.com/science/article/abs/pii/S0048969709004999
[32] Clarke, D et al., (2021) *Assessing future drought risks and wheat yield losses in England* Available at: https://www.sciencedirect.com/science/article/pii/S0168192320303506
[33]:http://fis.freshwatertools.eu/files/MARS_resources/Info_lib/MARS_Deliverable_D2.1(part4)_Report%20on%20the%20MARS%20scenarios%20of%20future%20changes%20in%20drivers%20and%20pressures%20with%20respect%20to%20Europe_s%20water%20resources.pdf

like the Thames. This could challenge the delivery of ecosystem services, including water quality for human and industrial use.

Other recommendations in this goal area also call for more communication and collaboration between environmental scientists, regulators, water companies, and planners to address the economic and human dimensions of water use and protection of river ecosystems. Enhancing research to refine models and more integration of factors like water quantity, quality, and abstractions, particularly for wetland ecosystems was also mentioned.

## Clean air

**Overview of studies in this goal area**

Number of sources in the shortlist: six

Principal methodologies: four quantitative, one qualitative, one mixed-method

Principal outputs: four projections, modelling & pathways, one scenarios, visions, SWOT analyses; one 'Horizon scans, Delphi, Issues papers'

### The nature of the evidence base

This goal area was one of the least populated with only six sources and it was strongly quantitative in nature. Qualitative and mixed methods approaches did feature, but only in a limited way. In terms of output formats, they were primarily projections, pathways, and the use of modelling techniques. Very few horizon scans, Delphis and issues papers and scenarios were present.

### Inputs into environmental foresight

The goal area of Clean air comprised a small evidence base of six sources and most of the sources were quantitative projections. Environmental drivers such as air quality and air pollution levels were among the main drivers. Other present drivers were social drivers such as increased traffic, altered land use and greater demands for fuel impacting them. Similar to Clean and plentiful water goal area, policy and regulation also featured as a common driver. Pollution targets and carbon pricing also inform the projections.

Uncertainties in this area related to scientific data and the methodologies used, such as modelling. Particularly, emissions from various sources and the aggregate representation of sectors in models introduced significant uncertainty into the process. Sources also acknowledged that used data might not fully capture actual conditions.

### Analytical processes

The methodologies described in the evidence base involved a combination of dispersion modelling, integrated assessment modelling, regulatory frameworks, and participatory workshops. Dispersion models like WinOSPM, AEOLIUS Full, and ADMS-Urban 2.0 are used to predict hourly concentrations of pollutants such as CO, PM10, NOx, and NO2 in street canyons. The performance of these models is also evaluated in the evidence base. While horizon scanning was present in this area, sources are predominantly quantitative.

Several integrated assessment models (IAMs) are used to project future air pollution levels, including IMAGE, MESSAGE-GLOBIOM, AIM/CGE, GCAM, REMIND-MAgPIE, and WITCH-GLOBIOM. The

United Kingdom Integrated Assessment Model (UKIAM) is utilized in setting proposed targets for the reduction of PM2.5 as part of the UK Environment Act. This involves scenario analysis to evaluate the potential for emissions reduction and associated benefits.[34]

Uncertainties in the data and modelling techniques are accounted for in the process through using multiple models in the analysis, empirical validation and likelihood and uncertainty marking. Error ranges and confidence intervals are used to quantify uncertainties and express results relative to a baseline for comparison. Literature compassion and multiple scenarios are also used.

### Recommendations and outputs

Multiple emission reduction projections are explored in the evidence base. There is overlap with the Thriving plants and wildlife goal area as nitrogen emissions and their effect on biodiversity is an area of focus. Projections of nitrogen emission highlight that reductions are unlikely to restore plant biodiversity to historical levels by 2030, indicating ongoing threats to ecosystems. Other emission reductions include particulate matter (PM) 2.5 reductions. Scenarios that modelled different levels of ambition for PM2.5 emission reductions suggest possible health and environmental benefits from aggressive policy actions.

Recommendations are made about policy and the performance of models. The OECD's environmental outlook[35] finds that without new policies, significant environmental degradation is expected, including biodiversity loss and increased health risks from pollution. The evaluation of the air pollution models finds that they have reasonable accuracy but need refinement, especially for NO2 predictions.

## Minimising waste

**Overview of studies in this goal area**

Number of sources in the shortlist: three

Principal methodologies: 0 quantitative, one qualitative, two mixed-method

Principal outputs: One projections, modelling & pathways, one scenarios, visions, SWOT analyses; one 'Horizon scans, Delphi, Issues papers'

### The nature of the evidence base

This goal area had the least number of sources; however it was one of the few which had no purely quantitative sources. There were two mixed methods approaches, and one qualitative approach. Although a small evidence base, it had a breadth of output formats spread between projections, modelling and pathways, horizon scans Delphis and issues papers.

### Inputs into environmental foresight

In line with the thematic focus of this goal area, it is unsurprising that consumption patterns is one of the main drivers examined in the evidence base. The influence of consumer behaviour on resource utilization and waste generation is a key consideration for this goal area and factors such as consumer

[34] ApSimon, H et al., (2023) *Integrated Assessment Modelling of Future Air Quality in the UK to 2050 and Synergies with Net-Zero Strategies* Available at: https://www.mdpi.com/2073-4433/14/3/525
[35] https://www.oecd.org/environment/indicators-modelling-outlooks/oecd-environmental-outlook-1999155x.htm

spending, household consumption, economic growth, service provision, and lifestyle choices play a role in shaping this. Analysis into the intensifying interrelation between waste management and energy sectors is also present.

Uncertainty is not well acknowledged in the evidence base for this goal area, but there is mention of a lack of comprehensive, long-term datasets which hinders the construction of robust models and reliable forecasts of future waste growth and the need for enhanced data quality and better modelling methods to improve prediction reliability.

### Analytical processes

In this goal area, scenarios are developed through qualitative narratives driven by factors like household formation rates, eating habits, and gadget consumption. These narratives, which envision future waste generation impacts, are translated into quantitative assumptions for waste projection models. Projects like TOSUWAMA and CEESA also contribute significantly by using a variety of tools to analyse policy instruments related to waste management and recycling. Specifically, the CEESA project uses system and simulation tools to combine scenarios for analysing long-term sustainability strategies.[36]

### Recommendations and outputs

If current trends continue without new policies, waste generation may increase. However, the evidence base finds that more sustainable lifestyles could stabilize or reduce waste. This can be supported through policy decisions, governance, and technology, and requires strategic action and international cooperation.

The recommendations highlight the importance of resource conservation, particularly managing mineral resources and electronic waste sustainably due to their environmental impact. Nuclear safety is also emphasized, advocating for international cooperation for safe nuclear decommissioning to avoid negative environmental or health effects. Lastly, the use of regulatory and behavioural measures for effective waste management is suggested, as these strategies can significantly reduce waste and help achieve a sustainable environment.

[36] Münster, M et al., (2013) *Future waste treatment and energy systems – examples of joint scenarios* Available at: https://www.sciencedirect.com/science/article/abs/pii/S0956053X13003413

# Appendix 3: Analysis of goal interdependencies

The table below details the EIP goal areas addressed by each study we examined. This provides the basis for generating the summary matrix in the main body of the report. The correlations provided in the EIP Goal area correlation matrix are the correlations between the columns below and therefore show where there is overlap and where there isn't between the goal areas.

| Study ID | 1 - Clean air | 2 - Clean and plentiful water | 3 - Thriving plants and wildlife | 4 - Reducing the risks of harm from environmental hazards | 5 - Using resources from nature more sustainably and efficiently | 6 - Enhanced beauty, heritage and engagement with the natural environment | 7 - Mitigating and adapting to climate change | 8 - Minimising waste | 9 - Managing exposure to chemicals and pesticides | 10 - Enhancing biosecurity | Cross-cutting themes and policy responses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 4 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 5 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 9 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 10 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 13 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 |
| 14 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 15 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 17 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 23 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 25 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Study ID | 1 - Clean air | 2 - Clean and plentiful water | 3 - Thriving plants and wildlife | 4 - Reducing the risks of harm from environmenta l hazards | 5 - Using resources from nature more sustainably and efficiently | 6 - Enhanced beauty, heritage and engagement with the natural environment | 7 - Mitigating and adapting to climate change | 8 - Minimising waste | 9 - Managing exposure to chemicals and pesticides | 10 - Enhancing biosecurity | Cross-cutting themes and policy responses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 30 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 32 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 33 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 34 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 35 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 36 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 42 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 44 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 47 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 49 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| 50 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 51 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |
| 52 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 58 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |

| Study ID | 1 - Clean air | 2 - Clean and plentiful water | 3 - Thriving plants and wildlife | 4 - Reducing the risks of harm from environmental hazards | 5 - Using resources from nature more sustainably and efficiently | 6 - Enhanced beauty, heritage and engagement with the natural environment | 7 - Mitigating and adapting to climate change | 8 - Minimising waste | 9 - Managing exposure to chemicals and pesticides | 10 - Enhancing biosecurity | Cross-cutting themes and policy responses |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 61 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 62 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 63 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 64 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 65 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 69 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 70 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 75 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 76 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 77 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 78 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 79 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| 80 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| 82 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 83 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| 84 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 85 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| 86 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 |
| 87 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 88 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| **TOTAL** | **8** | **19** | **36** | **21** | **27** | **4** | **27** | **4** | **8** | **7** | **1** |

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