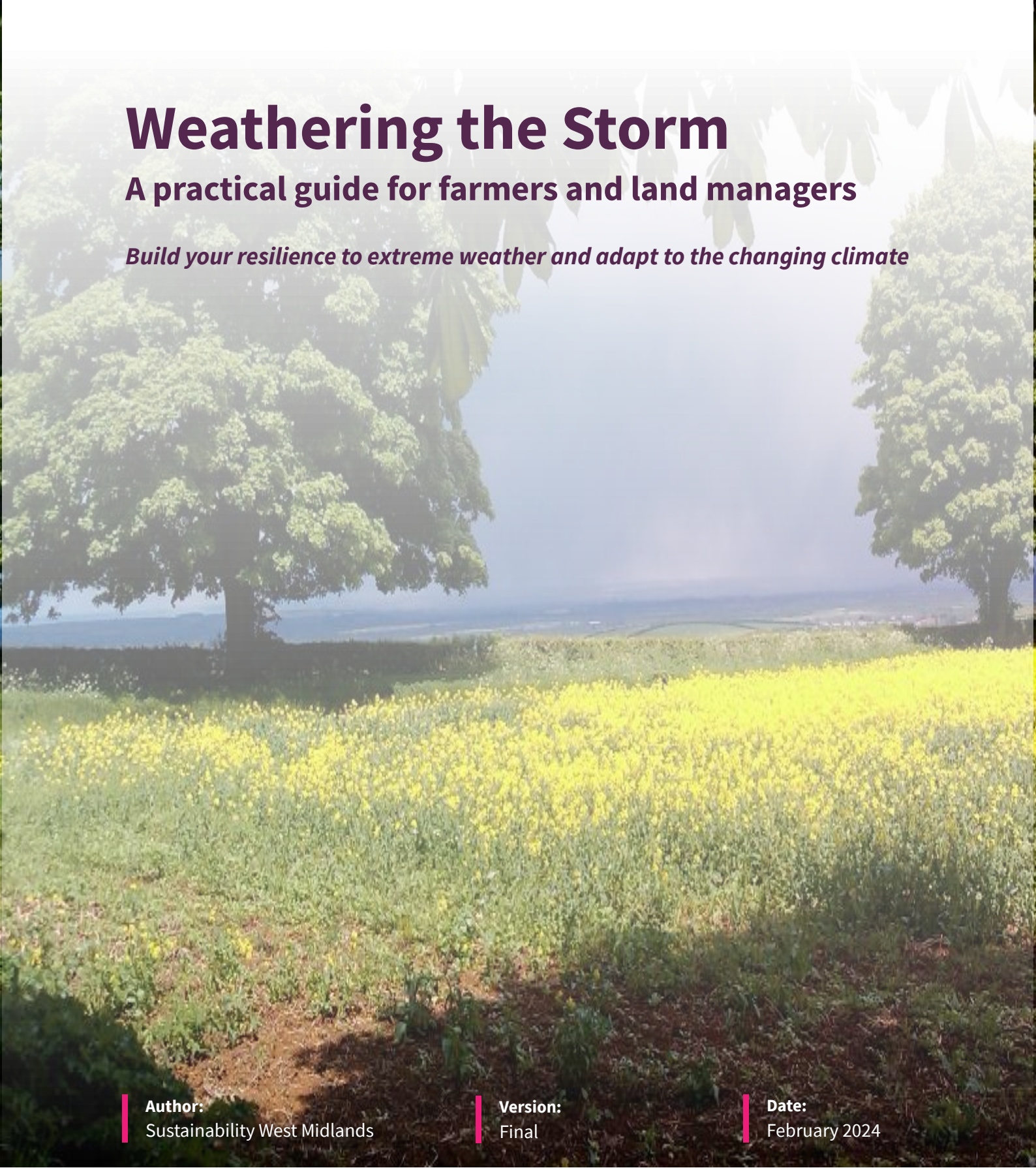
Weathering the Storm

A practical guide for farmers and land managers

Build your resilience to extreme weather and adapt to the changing climate



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Partner: Environment Agency

Project Manager: Alan Carr (SWM)

Report Author: Mike Peverill (SWM Associate)

Project Contributors: Kathryn Brown (The Wildlife Trusts), Jim Davies (Environment Agency), Sarah Faulkner (NFU), Charles Ffoulkes (ADAS), David Hassall (National Trust), Georgie Hyde (NFU), Keith Jones (National Trust), Prof. Jerry Knox (Cranfield University), Arwyn Owen (National Trust).

Quality assured by: Anna Bright (SWM)

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About Sustainability West Midlands

Sustainability West Midlands (SWM) was established in 2002 as an independent, not-for-profit company and our mission is to make the West Midlands region more sustainable, fairer and greener for all.

Our vision is that the West Midlands is leading in contributing to the national target of net zero greenhouse gas emissions by 2050 whilst addressing health inequality and driving inclusive growth. We monitor the West Midlands Sustainability 2030 Roadmap which acts as a framework that all organisations based or operating in the region can use to help them make changes to their activities in the knowledge that they will contribute to wider regional ambition.

SWM's support our members and other local stakeholders in the public, private and third sectors to implement these changes by enabling them to demonstrate innovation and leadership and provide opportunities to collaborate and celebrate success.

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Comment by the National Farmers Union

"Adapting to climate change is a topic of increasing importance for Midlands' farmers. Each year the impacts of a changing climate are felt ever more acutely. Farmers are at the sharp end of this, with businesses across the Midlands already struggling with the very real impacts of flooding, waterlogging, crop losses, high winds and increasingly erratic climactic conditions.

This document brings together crucial information that can help agricultural enterprises consider climate adaptation within their forward planning. Farmers already prepare a vast array of documents for their businesses, so an additional adaptation plan can seem like a big ask. However, there will be aspects that are pertinent to each business across the region. Putting in plans to bolster resilience now can help with incident responses in the future."

Sarah Faulkner, Regional Policy Manager, NFU Midlands

Image above: Farmers discussing the use of heavy machinery, which in wet conditions can cause soil compaction problems. This photo was taken during one of a series of on-farm workshops across the Midlands in 2013 for which the original Weathering the Storm guide for farmers was produced © Mike Peverill.

Front cover image: Summer storm clouds gathering over Broughton Hill, Leicestershire © Mike Peverill.

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Image 1: Checking soil health and looking for compaction in the roots of a wheat crop in Derbyshire © Mike Peverill

1. Introduction

1.1 Background and purpose

This is a practical guide for farmers and land managers which was originally produced in 2013 and has been updated in 2023. It is aimed primarily at those living and working in the Midlands though may also be useful to those further afield as much of the content can be applied elsewhere. It is designed to help farms and land businesses become more resilient to extreme weather, better adapted to the changing climate and more attuned to potential new business opportunities that may arise from a warming world.

Why is adapting to climate change important?

A series of extreme and record-breaking weather events have occurred during the early years of the 21st Century. Disruptive and destructive floods, droughts, heatwaves, wildfires and storms have become an increasingly regular feature of life over recent years in the UK and around the world, and such events are expected to increase in frequency and severity as the climate continues to change over the years ahead. Some anticipated changes for the West Midlands are shown below (figures from the UK Climate Projections 2018).

Baseline 2050 2099	Best-Case Scenario (RCP 2.6)		Worst-Case Scenario (RCP 8.5)	
	Summer	Winter	Summer	Winter
(Avg. temp.)	15.4°C 1.7°C warmer 2.3°C warmer	4°C 0.9°C warmer 1.2°C warmer	15.4°C 2.1°C warmer 6.5°C warmer	4°C 1.6°C warmer 4°C warmer
(Avg. precipitation)	171mm 17% drier 25% drier	195mm 4% wetter 7% wetter	171mm 23% drier 42% drier	195mm 7% wetter 24% wetter

Image 2: Summary of future climate changes in the West Midlands conurbation, taken from Weathering the Storm, SWM, 2022

1.2 How to use this guide

- **Use this guide to develop an adaptation plan** for your business to help you **become more resilient to the weather and climate change.** You cannot stop intense rainfall, heatwaves, storms or droughts, but having such a plan in place can help reduce the impact that they have on your business.

- Put some time aside to work through the five step action planning process outlined later in this document. **It can be done in under a day**, or in shorter bursts over a longer period. It can be done by one person but is better done as a group as it will prompt useful discussions, hence it will be beneficial to involve family members, colleagues and employees, as appropriate.

- Consider involving neighbouring farms or businesses if some of the issues raised are common challenges, or where **collective action might be more effective** and **costs could be shared**.

- Use the further information provided to help you work through the different stages, ideally reading it through in advance and using the links to additional sources where relevant.

- Use the checklist at the end to double check you have covered everything.

- Even if you do not have time to work through all the steps and produce a plan at the end**, do read through the checklist**. It is a useful prompt that will help you identify some key risks and encourage you to think about potential solutions, which is a good start in itself.

Having an adaptation plan in place, even if it is initially a bit rough and ready, is a really good first step to becoming more resilient to our increasingly unpredictable and extreme weather. It can also help you become more resilient to other unexpected events and shocks as it can also assist with assessing, anticipating and managing risks in the short and long term, which is good business practice. Many larger businesses have business continuity plans in place, a similar concept based on risk assessment and the identification of mitigation measures.

Although the guide is primarily designed to help farms and land businesses reduce the harm that can be caused by extreme weather, readers should also consider potential new opportunities arising from some of the more gradual climatic changes, such as the possibility of growing new crops or changing the rearing of livestock as in the example below. This document also allows the reader to explore the potential for landowners and farmers to look at nature based land uses to create resilient business, and funding opportunities as defined in the Government's Agricultural Transition Plan 2024.

In the face of rising sea levels, one farmer on the Suffolk Coast is anticipating losing 100 acres of grazing land by agreeing to breaches being made in the coastal sea defence. This will allow sea water into the area and the subsequent gradual development of salt marsh. Over time this will create new wildlife habitat which will provide a buffer zone against future coastal flooding. It will also have the potential to be grazed by sheep and to be sold as premium salt grazed lamb.

-- Story featured on BBC's Countryfile Vanishing Villages episode, broadcast on 5 March 2023.

It is important to stress at the outset that every farm and land-based business is different and so the risks, opportunities and potential impacts will vary accordingly. The location of your business, the type of farming or land management you undertake, the buildings and machinery you use, your supply chain and customer base will all be affected in different ways by climate change. There is no 'one size fits all' solution, hence any adaptation plans and actions should ideally be tailored to the needs of each farm or land management business.

1.3 Why is this guide needed?

It seems that levels of awareness and action on climate change adaptation (as distinct from the Net Zero agenda) are patchy across the land use sector. This is reflected in the news item and research paper quote from 2021 on page 8 of this document. That is not to say that there is no information available, but it is not all in one place and can be hard to locate. In this guide, we have tried to bring together from a range of sources the full breadth of information and advice to help you.

Note that the guide does not include detailed ‘how to’ undertake follow on actions, but instead attempts to synthesise, summarise and signpost some of the most helpful, relevant and recent ‘what to do’ material available.

A glossary is provided at the end of the document with definitions of the technical climate related terms used in the guide.

We must adapt to changing weather patterns

'Fifty seven percent of NFU members say they have experienced extreme weather conditions, such as flooding or drought, in the past ten years. The NFU sees a pressing need to further equip farmers and growers with tools to better manage extreme weather events.'

NFU news story, 10 August 2021

Managing extreme weather and climate change in UK agriculture: Impacts, attitudes and action among farmers and stakeholders

'Although the need for agriculture to adapt to climate change is well established, there is relatively little research within a UK context that explores how the risks associated with climate change are perceived at the farm level, nor how farmers are adapting their businesses to improve resilience in the context of climate change. This paper begins to address this gap by exploring experiences, attitudes and responses to extreme weather and climate change. The results point to a mixed picture of resilience to climate risks. All interviewees had experienced or witnessed negative impacts from extreme weather events in recent years but concern was expressed that too few farm businesses are taking sufficient action to increase their business resilience to extreme weather and climate change. Many farmers interviewed for this research did not perceive adaptation to be a priority and viewed the risks as either too uncertain and/or too long-term to warrant any significant investment of time or money at present when many are preoccupied with short-term profitability and business survival.'

R. Wheeler and M. Lobley, Centre for Rural Policy Research, University of Exeter
Published in the journal Climate Risk Management, 23 April 2021

Image 3. Harvesting wheat in Nottinghamshire © Mike Peverill

2. Resilience checklist

You can use this checklist at the end of the planning exercise to ensure that you have covered everything. The sections that follow this checklist provide more information and links to useful sources to help you explore the topics further and inform your responses.

If you do not have time to work your way through this document and the planning process described, then this checklist might be helpful as a standalone resource to prompt you to think through some of the issues and consider what to do differently.

	Soils	**YES**	**NO**	**N/A**
1.	Is the condition and health of your soil routinely monitored?			
2.	Is any action taken to reduce and avoid soil compaction?			
3.	Is organic matter regularly added to your fields?			
4.	Has direct drilling and/or minimum tillage been investigated as an option to reduce soil disturbance and machinery costs?			
5.	Are chemical inputs matched to crop requirements to help ensure good nutrient balance?			
6.	Is crop rotation used to help improve soil health and fertility and combat pests, weeds and diseases?			
7.	Is bare soil protected by continuous plant cover?			
8.	Has tree planting been considered in order to help restore degraded soils?			
9.	Is good drainage maintained across the farm?			
	Water	**YES**	**NO**	**N/A**
10.	If you use mains or abstracted water for irrigation, have you had any problems of drought or water restrictions in the recent past?			
11.	Have you investigated options and feasibility of increasing water storage, e.g. rainwater harvesting?			
12.	Have there been any issues with flooding in the past?			
13.	Are you aware of any planned or potential flood risk management schemes on your land or nearby within the same river catchment?			
14.	Are there any flood prevention measures in place, e.g. a slurry pit?			
15.	Are you experiencing any issues with high nutrient levels in streams, rivers or water bodies on or adjacent to your land?			
	Woodland and Forestry	**YES**	**NO**	**N/A**
16.	Are you aware of the risks to trees, woods and forests from climate change and the associated impacts (drought, flooding, fire, pests and pathogens)?			
17.	Have opportunities for planting new woodland been explored?			
18.	Is agroforestry a potential option to consider?			

19. Could the resilience of existing or new woodland be improved?			
Wildlife and Biodiversity	**YES**	**NO**	**N/A**
20. Do you monitor the diversity of wildlife on the farm (even informally)?			
21. Could you monitor and map the extent and quality of your natural habitats?			
22. Could they be improved and extended, including linking up with neighbouring farms?			
23. Have you investigated opportunities to fund improvements through the Environmental Land Management and Biodiversity Net Gain schemes?			
24. Have you made contact with your responsible authority for Local Nature Recovery?			
People	**YES**	**NO**	**N/A**
25. Has the health and safety of people on the farm been assessed in the light of extreme weather conditions?			
26. Have there been any weather-related accidents in recent years?			
27. Is there a contingency plan for what people need to do (or not do) in the event of an emergency like a major flood, storm or wildfire?			
28. Is everyone aware of the contingency plan and where it is kept so that it can be accessed by anyone?			
Farm buildings, infrastructure and access	**YES**	**NO**	**N/A**
29. Have the farm buildings and infrastructure been damaged or adversely affected by extreme weather in recent years (high winds, heavy rain, heatwave, wildfire, etc.)?			
30. Have adequate repairs been carried out such that damage will not reoccur during a similar or more extreme event in future?			
31. Is there regular checking and pro-active maintenance of buildings and infrastructure to ensure they are able to withstand more frequent and more extreme events in future?			
32. Is there potential housing/mineral extraction/infrastructure planned or being investigated on your land?			
Livestock	**YES**	**NO**	**N/A**
33. Have any livestock come to harm as a result of extreme weather in recent years (either directly or as a result of pests or diseases)?			
34. Have any changes been made as a result to help reduce risk in future?			
35. Has a risk assessment been made for all livestock to ensure there is adequate protection in place from all forms of extreme weather?			
36. Have you considered different breeds or species that might cope better in extreme conditions?			
Crops	**YES**	**NO**	**N/A**
37. Have any of your crops been lost/ damaged as a result of extreme weather events (either directly or as a result of pests or diseases)?			
38. Do you monitor crop yields and record how they have been affected by any extreme weather?			
39. Have you researched, considered or tried growing different crops that may be more resilient to heatwaves/drought or heavy rain/flooding?			

40. Have you been affected by wildfires at all, or do you know the risk from wildfires?			
Permitting	**YES**	**NO**	**N/A**
41. Do you understand the importance of climate risk considerations when undertaking any activities that require an environmental permit?			

3. Make a plan

In this section
- *Summary of the five step planning process*
- *Time and resources needed and Instructions for each step*

Making an action plan to help your business become more resilient to extreme weather and climate change can be done quite quickly and relatively easily. The five step process outlined here was devised and tested extensively (in different variations) over time with many different organisations in a half day workshop format. It can always be refined and improved later and the subsequent sections provide more information to help you do this, but a rough and ready plan is a good start. Once you have a plan and have refined it, this can be reviewed on a regular basis as part of your wider business planning such that climate considerations become an automatic part of your thinking.

You can do this exercise on your own, but depending on the size and scale of your business, you may find it helpful to involve other family members, colleagues or staff. It may also be beneficial to invite your neighbouring businesses to participate, as some of the risks will be common and some of the solutions may require cooperation in order to be most effective, or more affordable if the costs are prohibitive but could be shared. Talking the issues over between several people was found to be one of the main benefits of the workshop format. Everyone brings a different perspective and this usually helps generate a healthy discussion.

The Steps
1. Record your current vulnerability
2. Identify your future risks (and opportunities)
3. Assess the risks you have identified
4. Decide how to mitigate the highest risks (and seize any opportunities)
5. Form your action plan

What you will need
- Blank flipchart paper
- Fine marker pens
- Blank postcards or large Post-It type notes
- A large 5x5 risk matrix, drawn up in advance on a large piece of flipchart paper (copied from the version below)

1. Record your current vulnerability

To maximise the value of this first step, this can be done as a preliminary exercise as it may take a little while to track down all the relevant details of dates, costs, etc. It is these details that provide the real value and help set the scene for, and inform, the subsequent steps.

To understand your own vulnerability to the current climate, make a list of all the times over the last 10 years when you have been impacted by severe weather. For each one, elaborate on what happened, the timescale, how you responded at the time, the disruption, the cost involved and what happened as a consequence. The clearest way to lay this out is in a table, e.g. on a spreadsheet.

Once complete, this list provides a good summary of your vulnerability to the current climate and hopefully some food for thought. Most people find that this an eye-opening exercise, particularly when you total up all the costs and disruption over time.

2. Identify your future risks (and opportunities)

The next step is to think ahead to what may happen in future, to the possibility of further extreme weather events, longer term trends and the potential impacts of these on your business over the next 10 to 20 years. A useful way to do this is to think about each of these headlines in turn:

a. Hotter, drier summers
b. Milder, wetter winters
c. More frequent and intense weather extremes
d. Sea level rise (important to consider if you are located near the coast)

Then, plot these on a large sheet of paper in the centre of a series of concentric circles, as shown in the example below. Use a new sheet of paper for each of the four headlines above.

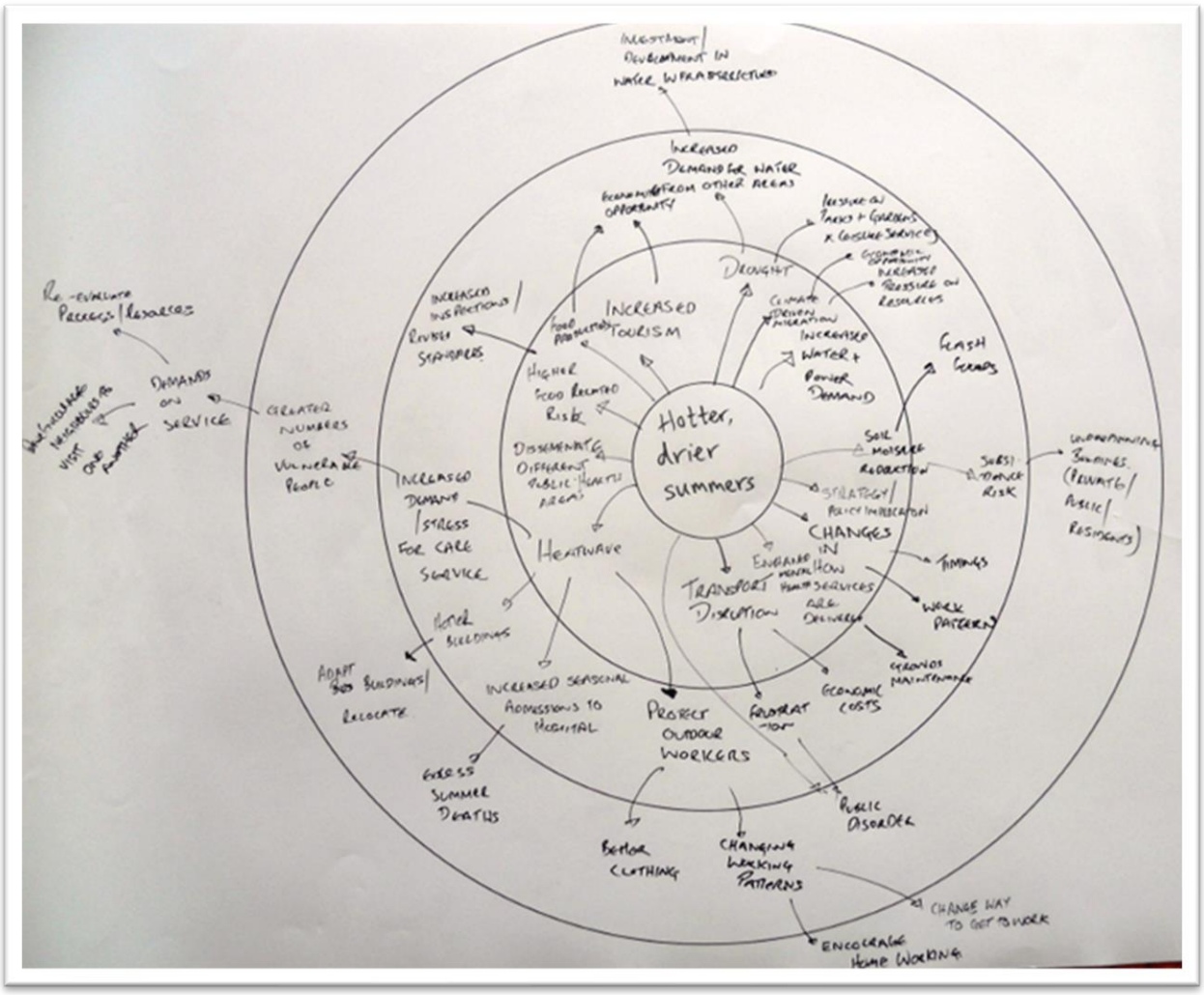

Image 4. Concentric circles diagram © Mike Peverill

Remember to take into account the additional implications of each of these headlines, as set out in the box below, which if relevant, can be written on as branches extending out of the centre circle. Next, identify all the different ways in which these trends or events are likely to impact on your business and note them on the diagram in the form of a branching tree or 'mind map.'

Often, there will be a series of cascading effects as one thing leads to another. Note these down on the paper with each cascading effect in the next circle out. Sometimes one effect will lead to several subsequent impacts (this may have been apparent when you worked through Step 1), so draw these on as branches. Also note down any opportunities you identify, using a different colour pen to differentiate them.

Hotter, drier summers are likely to lead to:

- A decrease in soil moisture
- More very hot days (e.g. over 27°C in the Midlands)
- More heatwaves (when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold)
- Reduced rainfall and greater likelihood of drought
- Downpours may be more intense due to warmer air holding more water vapour

Milder, wetter winters will mean fewer very cold days and reduced frost and snow, but cold spells will continue. There is likely to be more rain in winter overall, including some more intense rainfall.

More frequent and more intense extremes of both temperature and rainfall are expected whilst more winter storms, including disproportionately more severe storms, are projected to cross the UK in the longer-term, together with an increase in near surface wind speeds.

Sea levels are continuing to rise, although the rate is not uniform around the UK coast. For example, for London by the year 2100, the projections indicate sea levels will rise between 0.29 metres and 0.70 metres in a world where we reduce greenhouse gas emissions, and between 0.53 metres and 1.15 metres (in a world where emissions continue to rapidly rise) with an associated increase in the risk of coastal flooding and saline intrusion. By contrast, in Edinburgh, the projected range of increases are between 0.08 and 0.49 metres (low emissions) and between 0.30 and 0.90 metres (high emissions).

3. Assess the risks you have identified

Next, for each of the most significant impacts, write each of these on a card using a marker pen so they can be seen easily, and assign each one a risk score. To do this, first think of the likelihood of this occurring and score it between 1 and 5. Write it on the paper, then think about the impact and score this 1 to 5 and again write it down. Now multiply these together and write down the number; this will lead to a risk score.

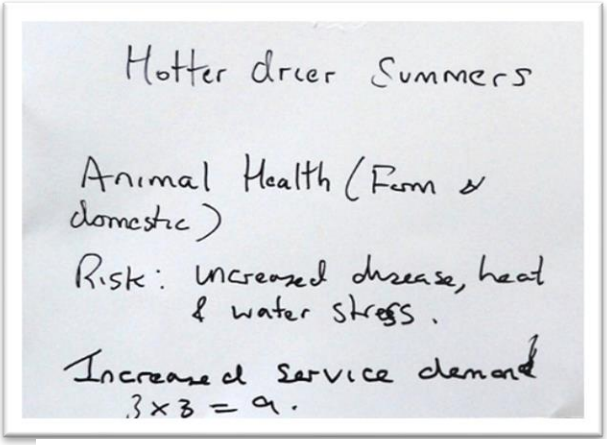

Image 5. Example of a risk card with impact (animal health), associated risk (increased disease) and risk score (likelihood 3 x severity 3 = 9). © Mike Peverill

Now place these cards on a standard risk assessment matrix as shown overleaf to provide a visual overview of your future climate risks. You might want to review the scores and discuss the results to check that they are all in the right place. The matrix helps you prioritise which risks most need mitigation, with the green cells being low risk, yellow is moderate risk, orange is high risk and red is an extreme risk. This makes for a good workshop activity if there are a number of you involved.

When undertaking this exercise, do not forget to consider your environmental permits. You need to integrate climate change adaptation planning into your permit management system if your permit was issued on or after 01 April 2023. If it was issued before this, you still need to complete a climate change adaptation risk assessment by 01 April 2024. More details on this is given in section 7.9 of this guide.

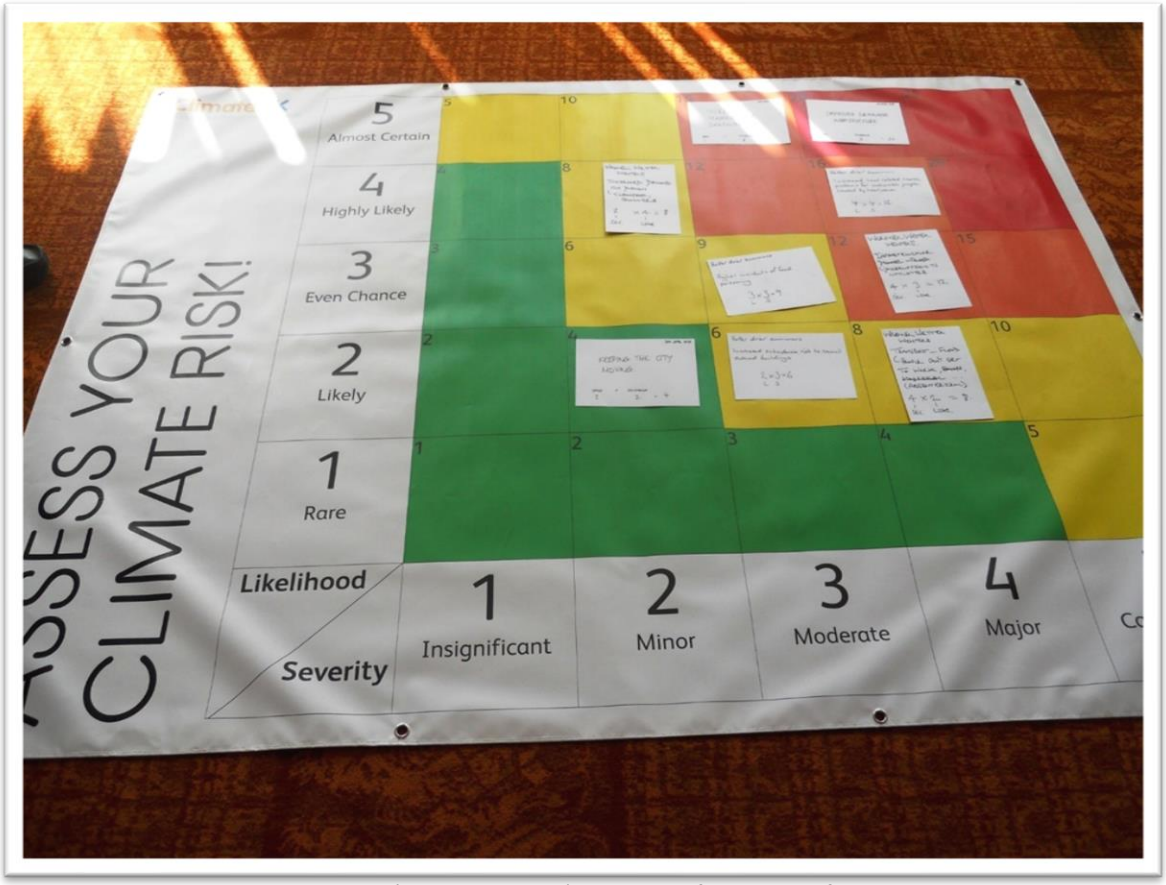

Image 6. Risk assessment matrix (© Mike Peverill), in banner form above for workshop use, and basic table, below

Impact					
5 catastrophic	**5**	**10**	**15**	**20**	**25**
4 major	**4**	**8**	**12**	**16**	**20**
3 moderate	**3**	**6**	**9**	**12**	**15**
2 minor	**2**	**4**	**6**	**8**	**10**
1 insignificant	**1**	**2**	**3**	**4**	**5**
	1 rare	2 unlikely	3 possible	4 likely	5 highly likely
	Likelihood				

Image 7. Risk assessment matrix example

4. Decide how to mitigate the highest risks (and seize any opportunities)

The next step in the process is to consider how best to mitigate the risks you have identified, particularly those with the highest scores, i.e. those in the red or orange squares. You might identify more than one potential action which is fine; note them all down for now. Or you might struggle to identify anything specific which is also fine; adaptation action often involves collecting further information or data, or maintaining a watching brief over time. Remember to consider separately any opportunities you have identified and make a note of what you need to do in order to capture any of these.

5. Build your action plan

The final step is to organise those potential measures or adaptation options into an action plan, to help you decide the specifics of what needs doing, when, by whom and with what resources. Again, if there are several people involved in the process this is another useful discussion opportunity, where you can share out the tasks of detailing the actions, noting them down on blank cards (again using marker pens so that they are easy to see afterwards). Once everyone has finished, lay out the cards on a table starting with the list of scored risks in priority order down the left hand side, and talk through the results to make sure it all makes sense. We used a large printed banner when this was done as a workshop exercise, but as long as you write the headings down on pieces of A4 paper (as shown in Image 8), a tabletop works fine.

Image 8. Adaptation action plan grid, with handwritten postcards showing the details © Mike Peverill

If you have identified more than one measure per risk, it can be helpful to categorise each one to help you decide which is most viable. Typically adaptation options are categorised as:

- **No regrets**: adaptive measures that are worthwhile (i.e. they deliver net benefits) whatever the extent of future climate change.
- **Low regrets**: adaptive measures for which the associated costs are relatively low and for which the benefits, although primarily realised under projected future climate change, may be relatively large.
- **Win–win**: adaptation measures that have the desired result in terms of minimising the climate risks or exploiting potential opportunities but also have other social, environmental or economic benefits.

- **Flexible**: involve putting in place incremental adaptation options, rather than undertaking large-scale adaptation in one fell swoop. This approach reduces the risks associated with being wrong, since it allows for incremental adaptation over time.

6. Consider policy levers and opportunities

Section 8 of this guide outlines three new (as of 2024) Government policy initiatives that may help farmers and landowners to implement their action plan. All of them relate to opportunities and potential funding that farmers and landowners can access to strengthen their resilience, and how embracing and integrating nature-based solutions at site-level can provide multiple benefits and financial incentives. It is recommended that you consider early on in the action planning process how you may be able to integrate these incentives to improve your resilience to extreme weather impacts. See section 8 of this guide to find out more.

4. Understand current climate vulnerability

In this section
- *Examples of climate impacts from around the country*
- *Hints for capturing your own experiences*

When you come to think about the impacts on your own business that have occurred over recent years as a result of extreme weather and climate change (Action planning Step 1), it might be helpful to consider the following list. This was drawn from conversations with groups of farmers across the UK and was part of the CHAMELEON project, carried out by ADAS and the Met Office for Defra. Although not recent, it is useful in highlighting the wide range of impacts (including some positives too) that can occur as a result of different types of extreme weather and how these may vary from one farm to another, and from one location to another. Climate impacts can vary even within the same valley, with one side being flooded after a storm and the other side being fine, so it's important to apply this list to your individual circumstances.

It is recommended that you note down the dates and impacts of weather and climate change on your farm over time if this is not something already done, as this will help provide a useful record and also help you to monitor the effectiveness of your action plan in future. If your business becomes more resilient as a result of the actions being implemented, then the impact of future extreme weather events should be less.

Hot Conditions and Drought:
- Yield reduction; this is usually accompanied by increased prices
- Delayed harvest owing to slowed growth rate
- Increased pesticide/fungicide/herbicide costs owing to over-wintering pests/diseases
- Increased pesticide/fungicide/herbicide costs owing to increased generations of insects and increased incidence of disease
- Increased storage costs or decreased sales price owing to early sale
- Income reduction as risky land is removed from production and put under another land use e.g. agri-environmental agreements
- Indirect effect on livestock through water and feed availability
    - Increased feed costs
    - Increased silage spoilage
    - Increased water costs e.g. larger troughs or drilling a borehole
- Increase in mortality in poultry
- Decreased animal weight gain in pigs, poultry and livestock
- Increased cost of controlling animal house temperatures e.g. through insulation or opening and closing shutters
- Loss of milk production
- Increase in fertility problems
- Increased use of pesticide e.g. drenching for sheep
- Easier combinable crop harvest owing to it being dry
- Increased anti-biotic/vaccination costs for animals e.g. for pneumonia
- Extended grazing season either side of winter
- Lower feed costs during winter as animals eat less in milder winters

Wet Conditions and Flooding:
- Reduced quality of crop with associated lower sales price

- Increased cost of drying (both grain and straw)
- Poor seed quality for following year
- Repeat drilling owing to crop failure (too wet) or crop loss (flash flooding)
- Crop loss in the event of flooding and water logging
- Earlier autumn drilling to avoid being impacted by wetter autumns
- Changed date of pesticide applications to avoid loss, e.g. after Christmas
- Increased cost of re-application of pesticide lost in wet weather
- Increased soil erosion and loss in soil quality
- Longer housing period for livestock (a particular problem in Northern Ireland), and associated increased costs
- Re-seeding owing to crop failure (too wet) or crop loss (flash flooding)
- Increased mortality associated with flash flooding
- Increased costs to pump fields dry

Frost and Hail:
- Yield reduction in arable and horticultural operations (e.g. fruit, potatoes, sugar beet and maize)
- Repeat drilling owing to crop failure
- Reduced effectiveness of fungicides
- Increased expenditure on disposal of manure/slurry owing to a reduction in days when the land can be travelled in winter

Wind:
- Reduced number of spray days in arable systems
- Yield reduction owing to loss of grain from the seed head
- Increased mortality in outdoor poultry (literally blown away)

This list is not exhaustive by any means and is based on experiences over a decade ago. Since then, a series of further extreme weather events have taken place across the country and weather records have continued to be broken, as elaborated in section 5.

Hints

When you come to record your own experiences, it is helpful if you can include more detail as this will provide a richer picture of events over time. This may take a while to do, which is why it is suggested that this is done as a preliminary exercise, but can really help when you come to think about the future, and the risks and opportunities ahead. The details you might document include:
- What kind of weather event took place
- The dates that the event occurred
- A description of what happened
- Details of the specific impacts experienced
- Any disruption that occurred and for how long
- Any costs incurred from damages needing repair or income lost
- Any lessons learned

2022 Case Study: Home Farm, Wimpole Estate, Cambridgeshire

Image 9. Wimpole Estate © National Trust

Home Farm on the Wimpole Estate is looked after by the National Trust and is a 600ha mixed organic farm growing a range of cereals along with rare breed cattle, sheep and pigs on heavy clay soils. **It was particularly badly affected by the long, dry summer of 2022**, an unprecedented event for those working on the farm, even for those having worked there for over 40 years and who are used to hot, dry spells. This is in one of the driest parts of the country and is near where the UK's then highest temperature of 38.7°C was recorded in 2019 (until broken again in 2022 when 40.3°C was recorded in Lincolnshire).

Very little rain fell during the growing season, the soil moisture content remained low for months (as shown in Image 10 below) and the clay soil cracked in the summer heat. Along one track, a 30 foot long crack opened up and was so deep the bottom could not be reached with a six foot cane. Whilst the previous winter's sown crops were fine, the spring sown cereals suffered (particularly the oats) due to the dry conditions and the crop yields, and quality was much lower than usual.

Livestock were also affected, with lower birth rates in the sheep and fertility rates in cattle also dropping, which was a common pattern across the local area according to the local vet. There is usually more than enough grass but in 2022 it ran out and the animals had to be fed via other means. The forage yields for winter feed were also poor, meaning that getting beef cattle to finishing was very expensive.

Lessons Learned

Another impact was the loss of young trees following a major planting project on the estate, with less than a 50% survival rate amongst the 85,000 saplings planted. However, an agroforestry trial with 2,000 new apple trees fared much better, due to the use of a thick mulch layer. “This seemed expensive at the time” recalls farm manager David Hassall, “but we were glad we did it.” Given the subsequent losses of only 1-2% of the apple trees, it proved a worthwhile investment in maintaining soil moisture content.

The farm is very limited in its options for water. It is unlikely to be able to get an abstraction licence due to existing pressure on local water resources, so irrigation is not an option. A reservoir is also out of the question because the farm is part of a historic designed landscape. The approach instead remains on maintaining soil quality through crop rotations and grass leys, as part of the farm’s organic system and through the selection of crop varieties that can tolerate dry conditions.

Whilst the summer pasture has mature trees that animals gather under, in 2022 there simply was not enough shade for the livestock to move onto the arable leys. However, David thinks that the rare breeds kept at Home Farm, that are smaller than modern breeds, cope better with heat, so there were no noticeable increases in mortality. David thinks that mobile shade shelters might be needed in future and that further options will need to be considered to adapt Home Farm’s system to the changing climate longer-term. An on-site weather station helps to provide very useful data to help in such future decision making, as shown below.

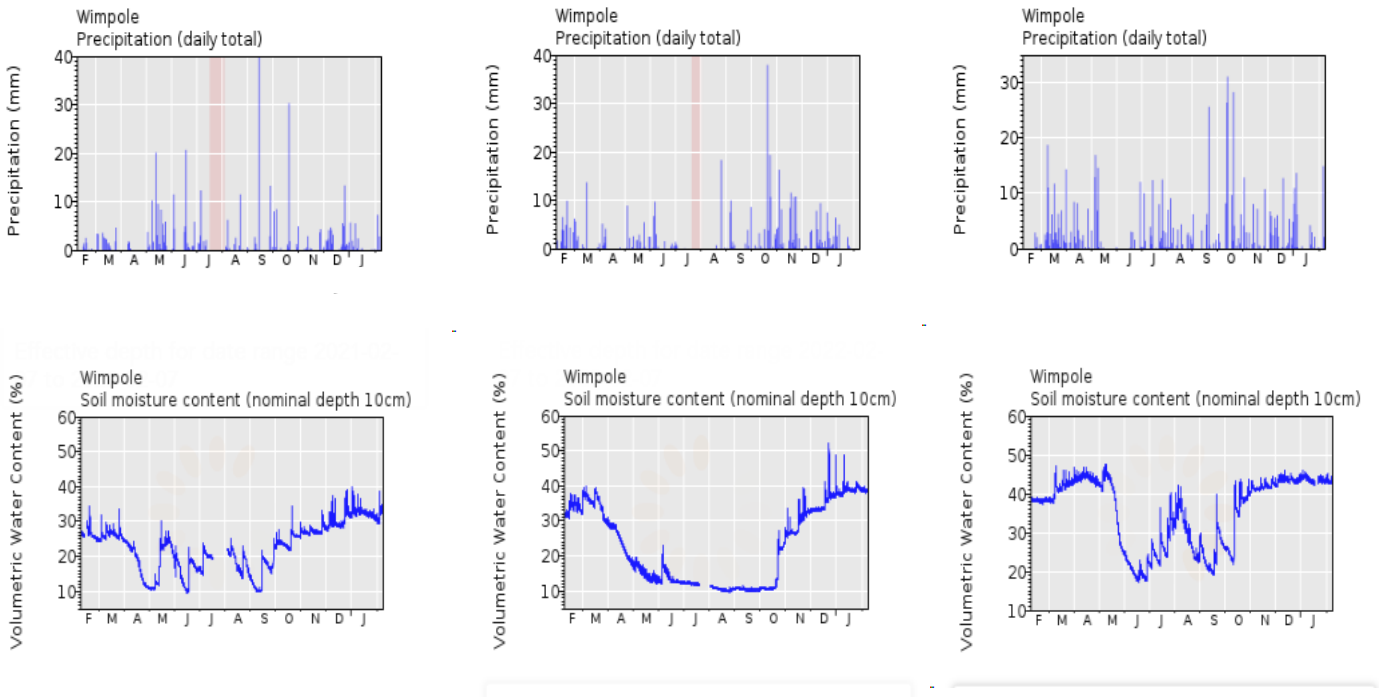

Image 10. Precipitation and soil moisture content charts for 2021 (left), 2022 (middle) and 2023 (right) for Home Farm (© National Trust). The dry spell of summer 2022 can be seen in the middle two graphs and is particularly stark, showing why the weather caused such major problems over the whole growing season.

5. Understand how the climate is changing

In this section
- *Observed climate changes, records and trends*
- *Future climate models and projections*

5.1 Introduction

To understand your future climate vulnerability, it helps to know a bit more about how the climate is changing via observations over time, and also how it is expected to change in future via observed and projected climate changes. From this, it is then possible to think about what specific risks are likely to result and how these might impact your own business.

It is becoming increasingly clear that climate change is not just something that might happen in the distant future but is with us here and now and is happening more quickly than many scientists predicted. The Met Office is a leading authority on climate science for the UK and here describes what has happened in recent years and also what is projected in future.

5.2 Recent UK climate observations

2019 and 2020 saw many extreme weather events. This included storms, floods and heatwaves. Some types of weather records are being broken more often than in recent decades. Here are some of the statistics and records from recent years, according to the Met Office.

2019 UK climate records

Four new national temperature records were set:
- Hottest winter temperature (21.2°C)
- Hottest summer temperature and record high in the UK (38.7°C)
- Hottest December temperature (18.7°C)
- Hottest February minimum temperature (13.9°C)

2020 UK climate records

During this year, some of the extreme weather events included:
- Wettest February on record, which brought storms Ciara and Dennis
- The sunniest spring on record
- 626 hours of bright sunshine (the previous record was 555 in 1948)
- Driest May on record for England
- The third hottest day on record (37.8°C)
- The wettest day on record in the UK overall, on 03 October 2020

2021 UK climate records

Specific events recorded in 2021 included:
- Fourth highest May rainfall on record
- First ever amber ‘extreme heat’ warning issued by the Met Office in July
- Third warmest Autumn ever recorded

- Storm Arwen in November led to ‘danger to life’ weather warning issued

2022 UK climate records

2022 was a year where many records were broken:
- Warmest year on record in the UK
- Warmest New Year’s Day on record (16.3°C recorded)
- Three named storms occurred within a week (Dudley, Eunice, Franklin)
- Hottest day ever recorded and first ever breaching of 40°C in July
- Tenth driest summer on record
- But the coldest start to a December for 12 years

Climate records and trends

We can also begin to observe numerous trends, with recent years bringing lots of extremes:
- Seven of the last 10 summers (2011-2020) have reached a temperature of 34°C
- July 2023 was the warmest month in Earth’s recent history, according to the Copernicus Climate Change Service
- Before this, just seven of the previous 50 summers (1961-2010) reached 34°C
- Six of the 10 wettest years on record have been since 1998

These records are not a definite sign of things to come. We also cannot say that climate change caused them, but it does make these types of events more likely, as described below.

5.3 How will climate change affect the UK in future?

Possible trends

Across the UK, we expect to see:
- Warmer and wetter winters
- Hotter and drier summers
- More frequent and intense weather extremes

Climate change will make these conditions more likely. The UK’s weather will continue to be variable, but we will see more of this type of weather. In the future, we will still see a lot of the weather we experience today. The difference, though, is that the intensity and frequency of some weather types will change.

You may have heard of Spanish plumes, which bring hot conditions in the summer. We could see these become more intense, creating even hotter summer weather. But Spanish plumes could also bring more intense downpours during summer thunderstorms. More rainfall could occur during winter storms, too. While the temperatures may be milder, winters will tend to be wetter, with more potential for flooding.

Climate change models

The UK Climate Projections (UKCP) are the Met Office's climate analysis and projection toolkit. The 2018 UKCP are the latest projections, which give us more detail than ever before. We use these projections to see how our climate may change over the coming decades. UKCP uses new, state-of-the-art climate models which lets us create global projections, as well as local projections in the

UK. The UKCP models are important in understanding the potential risks we face and helps inform the UK's mitigation and adaptation strategies for climate change.

More details of the latest climate projections for the UK from 2018 can be found on this page, including a 12 page summary and a 14 slide presentation.

Note that the UKCP also provides more spatial detail of variations between the four nations of the UK, between regions and river basins in climate change projections over land where you can examine maps of different climate variables, periods and time slices according to their future probability. Finer scale projections are also available via the UK Climate Projections User Interface but this requires registration and log in and is more complicated to use.

Summary

A helpful visual explanation of some key projected changes over time is provided in this graphic, from a 2023 Environment Agency publication 'Climate impacts tool: guidance for Environment Agency staff. Understanding the risks and impacts from a changing climate.'

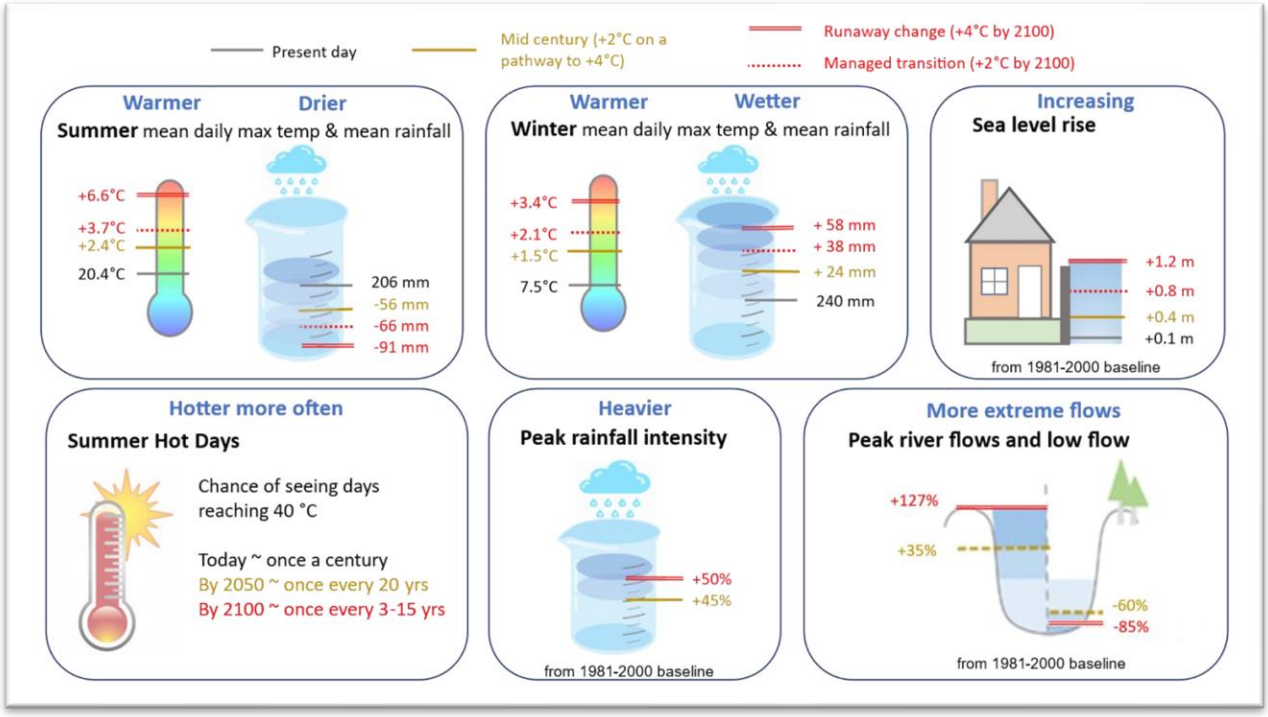

Image 11: Summary of likely future climate impacts © Environment Agency

6. Understand future climate risks

In this section

- *The most recent UK Climate Change Risk Assessment*
- *Key messages for agriculture and food*
- *The latest UK National Risk Register*
- *The top 10 UK business risks*

Following on from the previous section, with an understanding of how the climate is expected to change and that there are a range of possible future scenarios, you can now start to think about the likely risks that this will present.

The most recent detailed assessment of climate risks to the UK was completed in 2021 when the independent Climate Change Committee presented its statutory advice to the UK Government. To inform that advice, around 450 people from over 130 organisations contributed to the UK Climate Change Risk Assessment (CCRA3). This was the third such assessment carried out under the terms of the Climate Change Act 2008 on a five yearly cycle. The detailed findings of that independent assessment are provided on the UK Climate Risk website.

For agriculture and food, the key messages arising from CCRA3 are as follows.

- Future climatic changes, especially wetter or drier conditions, could significantly impact on UK soil health leading to implications for agricultural productivity.

- Agricultural productivity could be at risk under future climate scenarios. This could be as a direct result of more extreme weather (namely extreme heat, flooding, drought, sea level rise or saline intrusion), or due to a greater number of pests, pathogens and invasive non-native species.

- There could also be some opportunities for UK agriculture under a changing climate should new or alternative species become suitable for the UK, or due to longer growing seasons (if water is not a limiting factor).

- Agricultural land is an important contributor to parts of the UK's landscape character, meaning that changes to the former could directly affect the latter.

- The future impacts of climate change in the UK and overseas could pose risks to food safety and food security.

- To quote Sir James Bevan in 2022, 'water is the X factor for nature' and climate change will also impact on water resources, water quality and therefore on farming operations. The Government's Plan for Water promotes an integrated approach to delivering clean and plentiful water.

The risks and opportunities are summarised by the graphic on the next page, taken from the 14 page agriculture and food sector briefing. This is worth a read, though note that the actions recommended in CCRA3 are aimed at the UK and devolved governments to help guide their adaptation plans and policies, rather than farmers and landowners directly.

Image 12. Summary of risks from the CCRA3 Agriculture and Food briefing, 2021 © Climate Change Committee

Tip: these risks, where relevant to your own business, may be useful to include in your own risk assessment exercise (see section 3, step 2), taking account of their urgency scores, (particularly where it is red 'more action needed' or orange 'further investigation'). More details of how these nine risks were identified and assessed are contained within the relevant Technical Chapters of CCRA3, where N is Natural Environment and Assets, H is Health, Communities and the Built Environment and ID is International Dimensions.

The growing risks from extreme weather and climate change are also reflected in other important recent national assessments by Government and the insurance industry, including:

- UK National Risk Register 2023 which features a range of natural and environmental hazards (including flooding, drought and heatwaves) alongside those from terrorism, cyber-attacks, pandemics, nuclear accidents and others. Climate change is now listed as a chronic risk. This latest assessment goes on to outline a range of 'reasonable worst-case scenarios,' including wildfire, storms, high temperatures and heatwaves, low temperatures and snow, coastal flooding, fluvial flooding, surface water flooding, and drought. **These are worth reading through, particularly for the likelihood scores which you might consider using in the risk assessment for your own business.**

- The Allianz Insurance top 10 risks for UK businesses in 2022 listed climate change at number three (up from number six in 2021). It states that *'climate change is the biggest climber from 2021 showing this to be prominent in the minds of many business leaders… Aside from the obvious environmental impact, climate change can stress local economies, threaten company business models and pose widespread disruption to organisations. A Government report published in January 2022 has predicted that the cost of climate change to the UK could be at least 1% of GDP by 2045.'*

7. Develop Adaptation Options

In this section

- *Identify potential actions to take for soils, water, woodland and forestry, wildlife and biodiversity, people, farm buildings, infrastructure and access, and livestock*
- *Other useful guidance*

The next step, having completed your own risk assessment and identified the highest scoring risks, is to work out what can be done to mitigate these risks and, where you may have identified some opportunities, how these can be captured – these are your adaption options. Much has already been written about different aspects of managing climate risk and identifying adaptation options. This guide attempts to summarise some of the most useful points and signpost the reader to more detailed information where it is available.

There may be different options available, so it is important to consider which are best suited to your particular situation. This may often come down to what is most cost effective and how long it will take to implement, and will need to be considered in the context of other plans and decisions you need to make. A climate change adaptation plan should not be separate, but rather integrated into your overall planning and decision making process.

There are also new (as of 2024) policies and opportunities that may help to implement some of these aspects, as detailed in section 8.

7.1 Soils

The risks to soils from climate change were given the highest score of 'More Action Needed' in the recent Third UK Climate Risk Assessment, with the key message '*future climatic changes, especially wetter or drier conditions, could significantly impact on UK soil health leading to implications for agricultural productivity.*' Hence, actions to improve or maintain soil health are critical.

Image 13: On farm soil management workshop in Nottinghamshire © Mike Peverill

This is reflected in the NFU's 2022 report '[The Foundation of Food - our vision for good soil health.'](#)

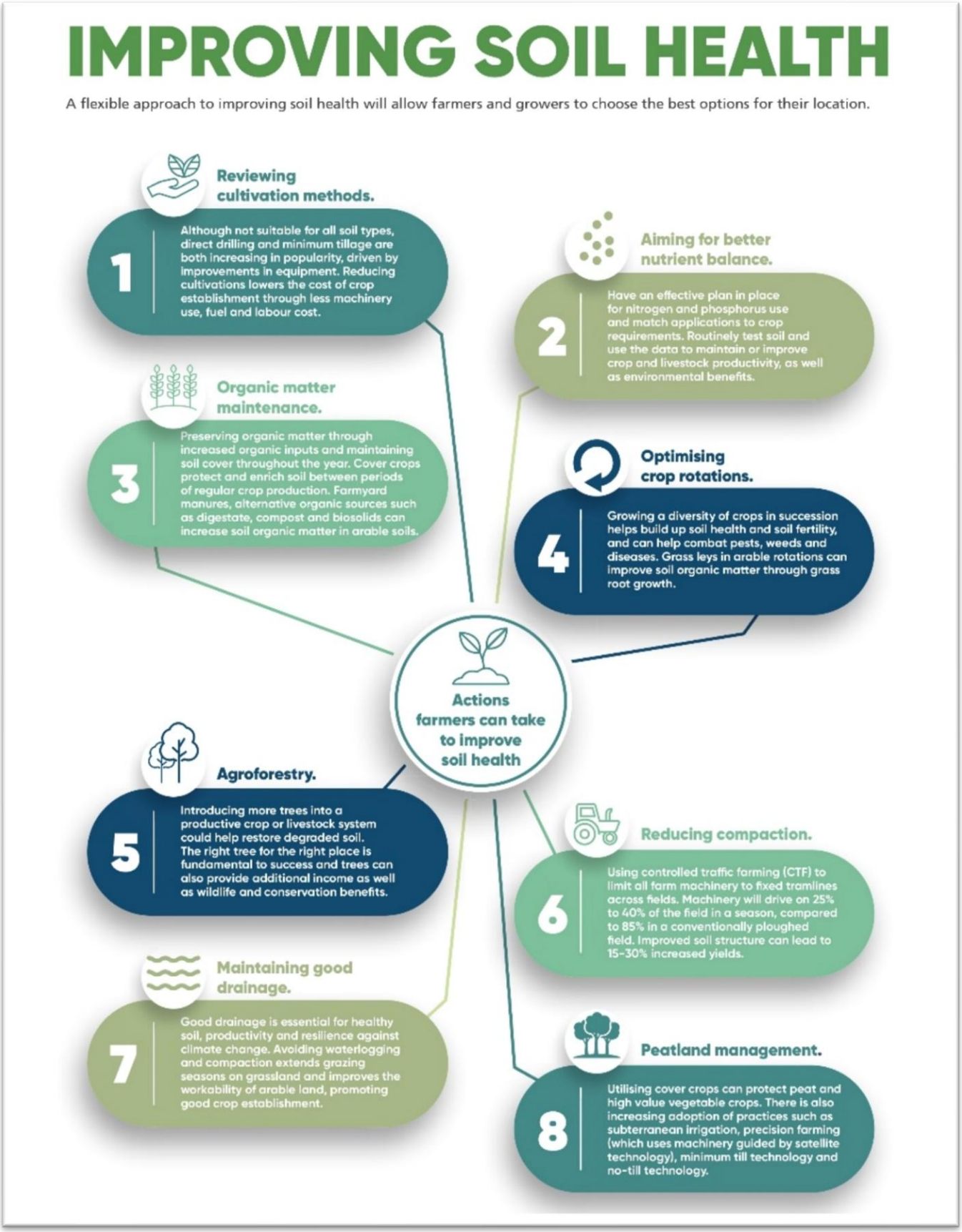

Image 14. Eight actions for good soil health © NFU

The Soil Association offers some similar advice from an organic perspective in its 2021 report 'Saving our Soils: healthy soils for our nature, climate and health' which lists seven ways towards better soil health:

1. Monitor soil health on farms
2. Increase the amount of plant and animal matter going back on to fields
3. Improve soil life by reducing tillage and chemicals
4. Cover up bare soil with continuous plant cover
5. Bring more trees on to farmland
6. Reduce soil compaction from machinery and livestock
7. Design crop rotations to improve soil health

Those wanting to learn more about improving soil health via Conservation or Regenerative Agriculture (including no-till, cover crops and re-introducing livestock into the arable rotation) may be interested in the annual Groundswell conference held each June since 2015 at the Cherry family's Lannock Manor mixed farm in Hertfordshire. In 2022, the event attracted 5,500 delegates.

7.2 Water

Too much and/or too little water have always been twin challenges for farmers and growers but climate change will make these challenges harder to manage with the trend towards hotter, drier summers and milder, wetter winters leading to aridity and drought on the one hand and flooding on the other, as a result of extremes. This is a major factor in the high risk to soils (see 7.1, above), so in addition to good soil management, good water management is another important response.

The development of Local Nature Recovery Strategies (LNRS) for all local authorities in England (see section 8.2) also provides an opportunity for land managers to improve their on-site water management. An example could be through the creation of ponds and wetlands, whereby if placed strategically, this could help to reduce flood risk while boosting opportunities for wildlife. The Government, via its Plan for Water, recognises that an environmental and sustainable supply of water is essential for people, businesses and nature. Chapter one is focused on explaining how a new approach to water management must be taken across water companies and through land management to ensure an effective integrated approach across river catchments.

Good water management is also acknowledged both by the NFU and the Country Land and Business Association (CLA) in recent reports. The NFU's Integrated Water Management 2021 report highlights the importance of on-farm actions like rainwater harvesting and reservoir construction and details particular challenges and opportunities for different types of arable and livestock farmers. But it also highlights how the management of water will sometimes require action beyond the farm level, require new forms of cooperation (which is why it may be a good idea to involve your neighbours in the five step planning process) and calls for Government action to support a more integrated approach overall. Detailed 'how to' guides on new reservoir construction and rainwater harvesting are available on request from SWM. They are a few years old but still contain lots of valuable and practical information.

The CLA's Water Strategy, 'a vision for the water environment to 2030' (2021) makes a call to action for farmers and landowners for improved stewardship of the water environment, notes the growing demand for water and makes the point that water is used in many ways throughout the rural economy. It also highlights the need for fair regulation, good policy, funding and facilitated collaboration with a range of other stakeholders. The report identifies solutions that work and

makes detailed recommendations for how Government can support farmers and landowners to improve the water environment.

If you rely on mains water or abstraction to irrigate vegetable crops, soft fruit or horticulture, you may benefit from a new, free online tool called D-Risk. This has been developed by Cranfield University to help you understand your drought and abstraction risks and calculate the potential benefits of rainwater harvesting and storage for polytunnels and greenhouses.

7.3 Woodland and Forestry

Planting more trees and woods can provide significant rewards to land managers when it comes to making your land more resilient to climate change. Planted in the correct place, trees and woods can reduce flood risk and minimise solar gain to reduce the risk of heat stress in livestock.

As section 8 explains in detail, there are new (as of 2024) opportunities for farmers to encourage the planting of trees and woods on their sites, and why this is important. These include:

- Environmental Land Management Schemes, which can fund landscape scale projects such as planting of woodlands.
- Local Nature Recovery Strategies, which focus on biodiversity enhancement, in part through planting of trees and hedgerows.
- Biodiversity Net Gain, whereby developers are, as of February 2024, required to deliver a 10% 'net gain' in biodiversity which can include making improvements off-site, including on nearby farmland.

Image 15. Abandoned woodland © Mike Peverill

There are also lots of useful new resources now available following the establishment of the Forestry and Climate Change Partnership (FCCP) in 2022, a cross sector body working together to promote measures which enhance the adaptation of trees, woods and forests to climate change and associated impacts. In launching a new Accord in June 2022, the FCCP said '*climate change and the associated environmental impacts including drought, flooding, fire, pests and pathogens present serious threats to the health of our trees, woods and forests. There is an urgent need to improve the resilience of both newly created and existing woodland to climate change. This requires significant change to widely accepted and practised systems of woodland and land management. Greater awareness is needed for the importance of adopting a broader range of species, diversity of genetics, age and stand structure, and improved connectivity in the landscape.*'

In January 2023, one of the FCCP members Forest Research launched a Climate Change Hub, a '*one-stop shop for climate change adaptation information and guidance*' which is particularly helpful in listing out and detailing the various risks to trees, the consequences and potential adaptation actions that can be taken, along with videos and case studies.

Other resources available via FCCP include training days, webinars and some recent useful case studies resulting from the 'Managing for Resilience Awards 2022' organised by the Royal Forestry Society in partnership with the Forestry Commission, whose own guide 'Managing England's woodlands in a climate emergency' also provides a helpful list of impacts and adaptation measures, along with some indication of how different types of ancient and native woodlands may be affected by climatic trends.

7.4 Wildlife and Biodiversity

The ecological crisis, the ongoing and significant loss of habitats and species around the world, is a global environmental challenge alongside the climate crisis. In this country, the 2019 iteration of the 'State of Nature' report, published by the National Biodiversity Network, suggests there has been a 13% decline in the average abundance of wildlife in the UK since the 1970s, illustrated in the infographic on the next page. Although the statistics are alarming, the good news is that for farmers and landowners wanting to protect and improve nature on their land, that by so doing, this can also help them become more resilient to the changing climate.

The United Nations Environment Programme said in 2020 '*restoring and protecting nature is one of the greatest strategies for tackling climate change, but not just for the obvious reason that it sucks carbon out the air. Forests, wetlands, and other ecosystems act as buffers against extreme weather, protecting houses, crops, water supplies and vital infrastructure. The strategy of using nature as a defence against climate impacts is called ecosystem-based adaptation (EbA); in essence, look after nature and it will look after you.*'

The Nature Friendly Farming Network published its report 'Farming for Climate Action: What are we waiting for?' in 2022 claiming '*climate action is as much in the hands of farmers, crofters and land managers as it is in the hands of decision-makers.*' This report explores how on-farm habitats can act as nature-based solutions that help reduce greenhouse gas emissions while supporting farming businesses in becoming more resilient and protected against the effects of climate change. Its 'Practical Guide to Climate Action for UK Farming' is also a valuable starting point for considering the specifics.

Government funding and policy incentives are now being rolled out to help implement some of these opportunities, for example through improved management and creation or extension of

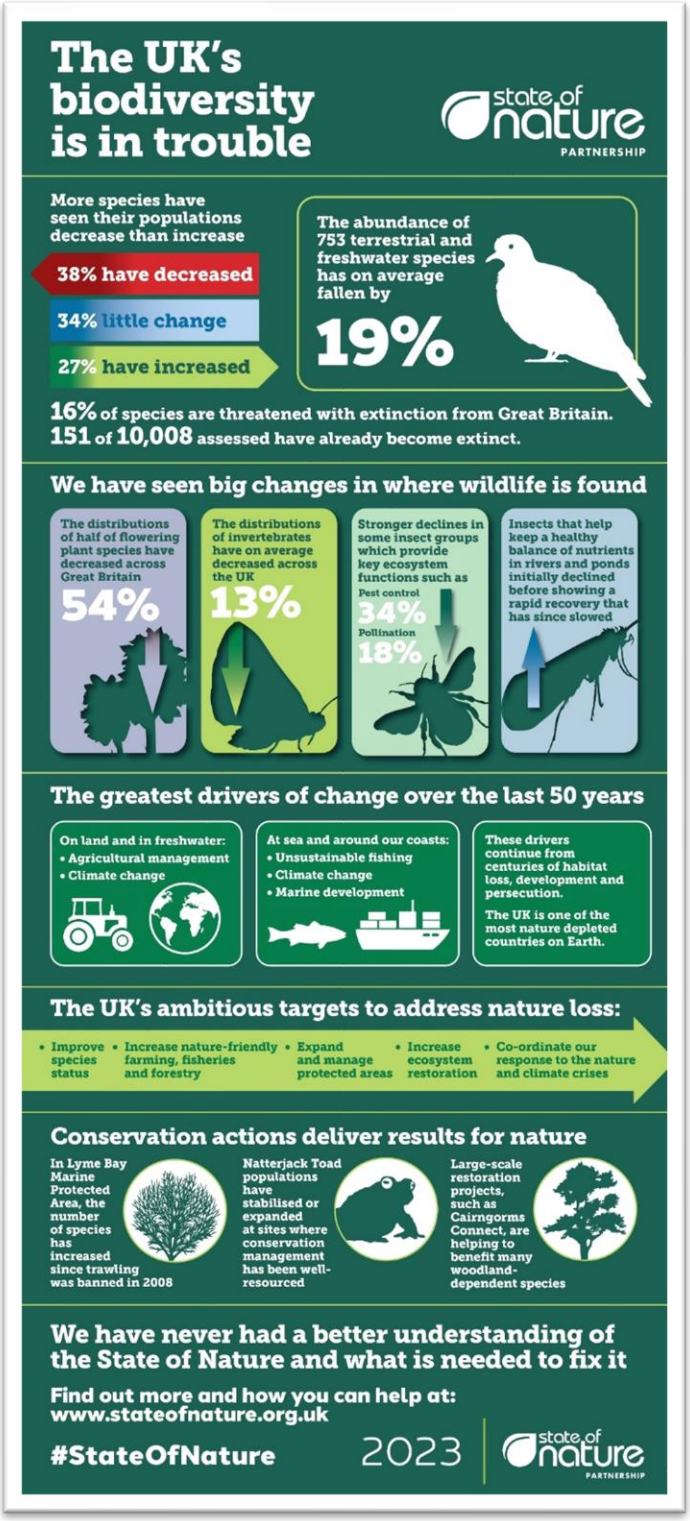

Image 16. The UK's biodiversity is in trouble, from State of Nature report 2023 © State of Nature Partnership (led by RSPB).

habitats, adding trees to fields or hedgerows, or restoring peat or wetland areas in appropriate areas of the farm. More details of the different policies and funding opportunities are provided in section 8.

Further relevant information for those keen to learn more can be found in the Oxford University report for WWF and the RSPB, 'Nature Based Solutions in UK Climate Adaptation Policy (2021),' which lists a wide range of 'natural interventions' that the authors claim help to address 33 of the 34 highest scored risks in the Third UK Climate Change Risk Assessment and help the UK adapt to a 2°C warmer world.

Also well worth a look is the 'Changing Nature, a climate adaptation report' published in 2022 by The Wildlife Trusts. Between the 46 individual trusts they manage over 100,000 hectares of land in nature reserves across the country. They considered all the relevant risks in CCRA3 (26 out of 61) and gave each one a score for the Wildlife Trusts collectively. They also looked at three indicators of climate risk from the University of Reading's Climate Risk Indicators website to see how risks from high temperatures, wildfire and low river flows might affect their reserves by 2050. Maps of each of these three changing risks helped show how reserves in different parts of the country might be affected under a 3°C global warming scenario. Observed impacts were also included in order to illustrate current vulnerability across the network.

The report also includes adaptation actions over the next five years in response to the risk assessment, and also taking into account the 'Lawton principles' of more, bigger, better, joined, i.e. improving the quality and size of habitat and joining it up wherever possible. The action plan is helpfully split up into actions by year to show what needs doing by when.

7.5 People

It is really important to consider the people in your family and business and how their health and safety may be adversely affected by climate risk. You may already have identified examples of this by going through the step one exercise in section 3 of this guide. Farms can be hazardous environments where the fatal accident rate is much higher than other industry sectors according to the Health and Safety Executive (HSE). Farmers are also subject to a range of factors that can adversely affect mental health, important to note given that extremes of rainfall, hot weather and wind or storms are likely to increase the risks to both physical and mental health.

It is worth checking existing good practice guidance, like the HSE's 'What a good farm looks like' to see where additional measures might be needed to manage the increased risks from extreme weather. The companion Weathering the Storm guide for small and medium sized businesses also has lots of useful content related to people that is also applicable to farming businesses.

During the series of climate workshops for businesses mentioned in the introduction to this guide, participants were advised by local authority emergency planners and a representative of The Institution of Occupational Safety and Health (IOSH) to put in place some simple measures to ensure their resilience in the event of an emergency. Key points included:

- Keep a contingency plan stored in an accessible location (including a digital back up) with written instructions and emergency contacts
- Make sure family and staff members know about it and where it is stored
- Keep a landline phone, as these have their own power supply so still work in the event of a power cut. In major flooding or storm events when key infrastructure has been affected and power is not restored for several days, it may be difficult to charge mobile phones.

7.6 Farm buildings, infrastructure and access

The physical environment of a farm or land-based business should also be considered as part of the climate risk assessment process. The following table from the Climate Just web portal provides a useful overview of generic impacts and potential adaptation measures for buildings. The Adapting Buildings section provides more information about how some buildings can increase exposure to climate hazards and what can be done to reduce vulnerability.

Climate/Weather event	Impact on the built environment and secondary impacts	Possible Responses
Floods	• Internal and external building damage. • Chance of slope instability. • Increased insurance premiums in flood risk areas.	***Property level interventions:*** door guards; air bricks; temporary flood barriers; vigilant maintenance; air tightness; flood resistant materials such as steel skirting boards and solid flooring; damage minimisation through, removable/replaceable doors on fitted cupboards; relocation of electrical plugs and appliances. ***Neighbourhood level interventions:*** Sustainable Urban Drainage Systems (SUDS); community level flood defences; greenspace interventions and appropriate management regimes.

Climate/Weather event	Impact on the built environment and secondary impacts	Possible Responses
Storms (including high winds)	• Greater chance of structural damage to buildings. • Risk of rain penetration in exposed areas.	***Property level interventions:*** Reinforcement of the building structure including roofs, and increasing the capacity of guttering and drainage down-pipes.
Cold events	• Cold related stresses on buildings (e.g. freezing pipes, frost heave on stonework). • Climate projections point to fewer events in the future and less energy needed for winter-time heating.	***Property level interventions:*** Vigilant maintenance; insulation. Installation of measures to further reduce energy demand and use (including use of energy efficiency measures).
Heat waves (including temperature increases)	• Chance of soil shrinkage and subsidence, particularly in clay soil areas. • Faster deterioration in concrete. • Internal overheating of some buildings, particularly traditionally constructed high-rise flats.	***Property level interventions:*** External solar shading (e.g. shutters); solar control window films; mechanical ventilation (air conditioning, fans); passive cooling measures (nighttime ventilation, wind ventilation, opening windows); enhance thermal mass in light weight constructions. ***Neighbourhood level interventions:*** Greenspace interventions for shade and cooling; appropriate greenspace management regimes (including drought management); protection of local open spaces.
Drought (including reduced summer rainfall)	• Chance of soil shrinkage and subsidence, particularly in clay soil areas. • Less water for building maintenance and residential use.	***Property level interventions:*** Rainwater harvesting, grey water recycling; measures to reduce household water demand and use (e.g. through installation of water efficiency measures).
Milder winters	• Chance of spreading infections.	***Property level interventions:*** Monitoring and maintenance; air quality management systems; ventilation.
Wetter winters	• Increased chance of damp in buildings.	***Property level interventions:*** Vigilant maintenance; rain screen cladding; ventilation.
Warmer summers	• Increased possibility of pests in buildings may cause damage, especially to historic structures.	***Property level interventions:*** Night ventilation for some pest problems. ***Neighbourhood level interventions:*** pest monitoring and control at property and community level.

For a further detailed checklist of weather and climate impacts on property, please see the Premises pages of the companion Weathering the Storm guide, starting on page 20.

Beyond the buildings, it is also important to consider potential climate impacts on the farm or landholding's other infrastructure, including roads (particularly those connecting the farm to the road network beyond), tracks, structures, drainage, energy, water and telecommunication systems. The initial step one exercise outlined in section 3 may have highlighted existing

vulnerabilities and pointed to where action(s) may be needed to improve the farm's resilience to future extremes of heat, cold, wet and wind.

7.7 Livestock

Defra guidance, updated in July 2022 during the heatwave, that focuses on 'Keeping farm animals and horses in extreme weather' provides some important pointers for managing during extreme hot weather and droughts, planning for and dealing with floods and extreme cold weather.

The NFU's Integrated Water Management 2021 report includes some useful content, especially on pages 12 to 14, on protecting livestock from flooding and ensuring adequate water supply, with additional material on the specific needs of dairy and poultry farming and a case study on the creation of an attenuation pond for new chicken sheds.

In the BBC's Heatwave Special programme broadcast in August 2022, well-known farmer Adam Henson discusses some of the issues for livestock farming arising from severe heat, for example the need for shade, sufficient water, a lack of grass and its knock on effect of requiring additional feed.

For intensive farming, the following recent (May 2023) Environment Agency guidance is comprehensive in terms of potential impacts across different extreme weather scenarios and also provides some potential adaptation options to mitigate the risks. Intensive farming: examples for your adapting to climate change risk assessment. See also section 7.9 on Activities requiring environmental permitting.

Image 17: Cattle in flood water near Stafford © Alan Carr

7.8 Crops

It is helpful to keep records of crops grown and yields, together with details of any extreme weather that occurred during the season to help build up a picture of what crops and varieties do well or badly in different situations. Details should also be recorded of any pests, diseases or

invasive non-native species that were encountered, as some of these are expected to become more problematic over time.

When planning future crops and rotations, this will be essential knowledge to draw upon. It is also worth bearing in mind the findings of the CCRA3 from 2021. The following extract is from the Technical Chapter on the Natural Environment.

- **While opportunities from climate change are available (notably due to longer growing seasons**), risk magnitude is assessed to increase from **medium at present to high in future**. This is due to both increased climate exposure (heat stress, drought risk, wetness-related risks) and inherent socio-economic factors in the land use sector that increase sensitivity and vulnerability, especially for agriculture.

- The assessment identifies limited evidence on adaptation actions and a significant adaptation gap in addressing this risk, especially for agriculture, which also highlights the importance also of continuing research on adaptation strategies.

Hence it is important to keep an eye out for new research when planning future crops and land allocation, here for instance from the University of Sheffield's Institute for Sustainable Food, which discusses varieties of beans requiring 40% less water, and bread wheat that uses water more efficiently.

Some of the new incentives (as of 2024) detailed in section 8 may be able to assist with this. For example, the Environmental Land Management Scheme includes the Sustainable Farming Incentive which among other things aims to incentivise more efficient food production by optimising inputs.

7.9 Activities requiring environmental permitting

Farms and land businesses that are subject to environmental permitting and that are regulated by the Environment Agency now need to factor climate risks into their management systems. The Agency has recently refreshed its guidance on permitting, and climate change adaptation is now explicitly included.

If your permit was issued:
- On or after 01 April 2023, you need to integrate climate change adaptation planning into your management system.
- Before April 2023, whilst your management system should already consider climate impacts, you need to complete a climate change adaptation risk assessment by 01 April 2024.

The environmental regulations for farming (Farming Rules for Water, Storage of Silage, Slurry and Fuel Oil (SSAFO) regulations, and Nitrate Vulnerable Zones (NVZs)) govern the storage and application of organic and inorganic fertilisers, aspects of livestock management, and other aspects of farming infrastructure and practices where there is a risk of pollution or environmental harm. The Environment Agency regulates some 100,000 sites across England, checking that farms are compliant with the regulations pertinent to each one.

If you rear pigs or poultry, you may need an environmental permit. You must apply for a bespoke environmental permit to rear pigs or poultry intensively in an installation if you have more than:
- 40,000 places for poultry

- 2,000 places for production pigs (over 30kg)
- 750 places for sows

Specific Environment Agency guidance from May 2023 is available on this issue, and there is further recent Environment Agency guidance on the following permitted sectors which is very helpful in spelling out the potential climate risks across different scenarios within each sector, then suggesting potential adaptation options that help to mitigate the risks:

- Intensive farming: examples for your adapting to climate change risk assessment
- Food and drink production sites
- Biowaste plants.

7.10 Other useful guidance

The Scottish project 'Farming for a better climate' provides some very useful online, video and printed guidance from 2021, produced by SAC Consulting for the Scottish Government. It identifies a range of potential impacts arising from climatic trends and offers some adaptation options and detailed checklists (designed for Scottish farmers based on climate change projections for Scotland).

2022 Case Study: Hafod y Llan Farm, Eryri National Park, North Wales

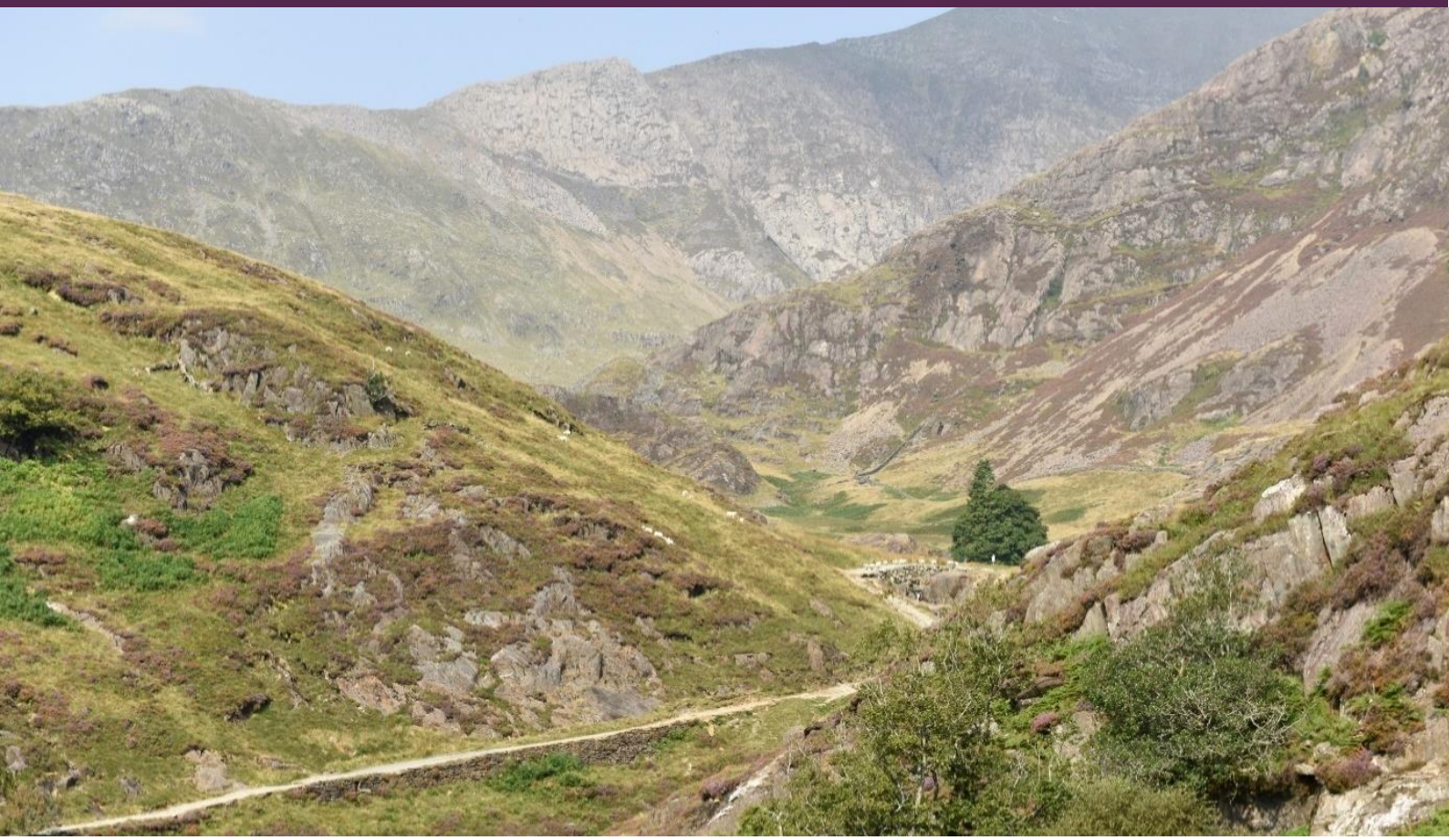

Image 18. Sheep at gathering coming down from Cwm Llan, Hafod y Llan © Wynn Owen, National Trust.

Hafod y Llan on the slopes of Yr Wyddfa (Snowdon) has been a National Trust estate since 2000 and incorporates the Trust's largest farm (1,840ha) which has been a hill farm for at least 200 years. This is a naturally wet part of the UK, and receives typical annual rainfall of more than 2,500mm. **In the unusually dry year of 2022 however, Hafod y Llan enjoyed one of its best years for its sheep, cattle and annual grass harvest.**

The estate is rich in protected biodiversity and industrial heritage and hence the National Trust has adopted a conservation farming approach which has seen sheep numbers halved. Grazing by the 1,500 ewes, 500 lambs, 30 pedigree Welsh Black cows and their 40 followers is carefully managed to encourage natural habitats to recover from earlier over grazing. An extensive farming system is employed with hardy Welsh Mountain sheep where lambing and other tasks are conducted outdoors. Grass is harvested each year and fed to the cattle over winter as either hay, haylage or silage, depending on the harvesting conditions, which were fine in 2022.

In 2022, lambing went well with a high survival rate and the cattle had good conception rates with a high percentage in calf. All the outdoor management tasks were more easily achieved thanks to the warmer, drier conditions. These also helped wilt the grass and enabled a good harvest without any ground compaction. Drier hay then means less water is baled, effluent is reduced and less straw is needed to soak up any moisture.

Lessons Learned

Farm Manager Arwyn Owen observed that sheep health was good during this time (and in some previous dry periods), due to a lower incidence of liver fluke, which is one of the biggest challenges for hill farming. The intermediate hosts of liver flukes, a type of mud snail, usually thrive in the damp margins around grazing areas, but in 2022 these areas dried out, which Arwyn thinks reduced the incidence of mud snails and liver flukes. He also noted that warm dry summers help stop the spread of rushes, which tend to out compete grasses during prolonged wet periods.

There are downsides to warmer summer weather as bracken can become problematic, fly strike is more likely and there could also be an increase in ticks, which would require more animal health measures. However, extended wetter conditions are more difficult overall, with manure storage capacity being another challenge at Hafod y Llan and further afield, with some local farmers questioning the long-term viability of sheep farming due to increased liver fluke.

“In future, we have to plan for more extremes, both drier and wetter, and the challenge for us is knowing what to expect” concludes Arwyn.

Image 19. The pedigree Welsh Black cows grazing Cwm Llan, just below Wyddfa (Snowdon) © Wynn Owen, National Trust.

8. Potential opportunities and funding sources

In this section
- *Opportunities for land managers that could help strengthen climate resilience*
- *An overview of relevant legislation*

The following new and recent (as of 2024) Government policy initiatives are included here both for context, as they are all relevant to farming, climate change and the natural environment, but also because they may provide opportunities to fund specific projects. For example, a qualifying project might improve wildlife habitat and at the same time improve a farm's resilience to certain climate impacts.

8.1 ELMS (Environmental Land Management schemes)

This is part of the Government's agricultural transition away from the EU Common Agricultural Policy towards a new UK system where farmers and land managers are paid to provide environmental and climate goods and services alongside food production via three schemes:

- **SFI (Sustainable Farming Incentive):** Designed to encourage sustainable farming practices that protect the natural environment, the SFI also aims to incentivise more efficient food production by optimising inputs, making better use of natural resources and improving animal health and welfare.
- **CS (Countryside Stewardship):** The new version of this long running scheme will pay for more targeted actions relating to specific locations, features and habitats, whilst CS Plus will incentivise bigger and better results through joined up schemes across local areas.
- **Landscape Recovery** is designed to support a small number of more bespoke natural environment improvement projects that are on a bigger scale and over a longer timescale and that typically involve groups of landowners working together. Up to 25 landscape scale projects will be supported in 2024 which could include creating and enhancing woodland, peatland, nature reserves and protected sites such as ancient woodlands, wetlands and salt marshes.

A further change has been made to ELMS via the Government's updated Agricultural Transition Plan (January 2024). This aims to maintain domestic food production whilst:
- Improving farm productivity
- Improving water quality, biodiversity and air quality
- Reducing agricultural emissions
- Mitigating the impacts of climate change

Annex 1: Plan for achieving environmental outcomes shows the Government's promotion of nature recovery within effective farming techniques, offering funding for measures to achieve the delivery of hedgerows, buffer strips and corner blocks, supporting agroforestry and mitigating flood risk and other climate change related impacts.

More information can be found in this Defra policy paper.

8.2 LNRS (Local Nature Recovery Strategies)

The Government has made legally binding commitments, via the Environment Act 2021, to halt ongoing declines in nature and to facilitate its recovery. In England, 48 strategy areas have been identified covering the whole of the country along with a responsible authority for each one. Each authority will prepare a Local Nature Recovery Strategy, in partnership with local stakeholders (particularly landowners and managers) to identify practical, achievable proposals to tackle agreed priorities in each strategy area. Examples include:

- Creation of wetlands
- Restoration of peatlands
- Planting of trees and hedgerows
- More sustainable management of existing woodlands and other habitats like grasslands

By March 2025, it is anticipated that such a strategy will be in place for all of the 48 areas across England and that each of these will be reviewed every three to 10 years.

The Government is putting in place a package of measures to encourage and support their implementation, including funding for specific activities within locations identified within the strategies and integrating the strategies into the planning system.

More information can be found in this Defra policy paper.

8.3 BNG (Biodiversity Net Gain)

This is a way of creating and improving natural habitats through the development process, where developers are required to deliver a 10% 'net gain' in biodiversity. This became a mandatory requirement in February 2024 under the Town and Country Planning Act 1990 as a result of the Environment Act 2021 and will be conducted via the local planning authority. The outcome of each new development should be either more, or better quality habitat than there was previously, on the site itself, or if not practicable off-site, or through a combination of the two.

The off-site element of this is where there may be opportunities for landowners, where they can sell off-site biodiversity units to developers. In exchange, the landowner then needs to implement an agreed plan to deliver that biodiversity gain, which in practice might include tree planting, creating a pond, seeding a meadow, etc. This then needs to be maintained for thirty years as part of a legal agreement. You will need to consult a qualified ecologist to understand how many biodiversity units you have at the outset and what opportunities you have for enhancement. You will also need to think carefully about pricing your units, as there are a number of costs involved including long term maintenance.

Landowners might consider either creating and enhancing habitats to meet the biodiversity net gain requirements of a particular development, or alternatively seek to maximise the biodiversity potential of their land, particularly where that involves a strategic priority within the Local Nature Recovery Strategy, before matching up to a development. The latter approach will help to generate more units per hectare and such strategic habitats will be mapped within the relevant Local Nature Recovery Strategy. If this is not yet published, you can consult your local planning authority who will be able to advise.

Consult the Defra guidance for land managers on Biodiversity Net Gain for more details and updates.

9. Glossary

The key terms listed in this document, and their definitions, are summarised below. The official definitions have been lifted from the Inter-governmental Panel on Climate Change (IPCC) 'Special Report on Global Warming of 1.5°C' (except where indicated).

- **Adaptation:** In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.

- **Exposure:** The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected. See also Hazard, Risk and Vulnerability.

- **Extreme weather event:** An event that is rare at a particular place and time of year. Definitions of rare vary, but an extreme weather event would normally be as rare as or rarer than the 10th or 90th percentile of a probability density function estimated from observations. By definition, the characteristics of what is called extreme weather may vary from place to place in an absolute sense. When a pattern of extreme weather persists for some time, such as a season, it may be classed as an extreme climate event, especially if it yields an average or total that is itself extreme (e.g., drought or heavy rainfall over a season).

- **Hazard:** The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. See also Exposure, Risk and Vulnerability.

- **Heatwave**: A period of marked unusual hot weather over a region persisting for at least three consecutive days during the warm period of the year based on local climatological conditions, with thermal conditions recorded above given thresholds (World Meteorological Organisation). In the UK, the heatwave threshold varies between 25°C and 28°C, according to the county (Met Office). Across the Midlands, the threshold is either 26°C or 27°C.

- **Impacts** (consequences, outcomes): The consequences of realised risks on natural and human systems, where risks result from the interactions of climate-related hazards (including extreme weather and climate events), exposure, and vulnerability. Impacts generally refer to effects on lives; livelihoods; health and well-being; ecosystems and species; economic, social and cultural assets; services (including ecosystem services); and infrastructure. Impacts may be referred to as consequences or outcomes, and can be adverse or beneficial. See also Adaptation, Exposure, Hazard and Vulnerability.

- **Risk:** The potential for adverse consequences where something of value is at stake and where the occurrence and degree of an outcome is uncertain. In the context of the assessment of climate impacts, the term risk is often used to refer to the potential for adverse consequences of a climate-related hazard, or of adaptation or mitigation responses to such a hazard, on lives, livelihoods, health and well-being, ecosystems and species, economic, social and cultural assets, services (including ecosystem services), and infrastructure. Risk results from the

interaction of vulnerability (of the affected system), its exposure over time (to the hazard), as well as the (climate-related) hazard and the likelihood of its occurrence.

- **Risk assessment:** The qualitative and/or quantitative scientific estimation of risks. See also Risk and Risk management.

- **Risk management:** Plans, actions, strategies or policies to reduce the likelihood and/or consequences of risks or to respond to consequences. See also Risk and Risk assessment.

- **Vulnerability:** The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. See also Exposure, Hazard and Risk.

-END-