National Audit Office

REPORT

Government resilience: extreme weather

Cross-government

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National Audit Office

Government resilience: extreme weather

Cross-government

Report by the Comptroller and Auditor General

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Gareth Davies
Comptroller and Auditor General
National Audit Office

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The National Audit Office study team consisted of:

Leon Bardot, Rachel Fenn, Alberto Vanzo, with assistance from Matthew Elliot, Brian Kennedy, Marie O'Donoghue and Ronan Smyth, under the direction of Sian Jones and Mfon Akpan.

For further information about the National Audit Office please contact:

National Audit Office
Press Office
157–197 Buckingham Palace Road
Victoria
London
SW1W 9SP

020 7798 7400

www.nao.org.uk

@NAOorguk

Key facts

8

of the 89 risks included in the UK government's National Risk Register are extreme weather events

Over 10:1

average benefits to cost ratios for water efficiency, and heat alert and heatwave planning measures from analysis undertaken for the Climate Change Committee

Over £1bn

estimated yearly economic cost of at least eight individual climate risks, including risks to businesses from flooding and risks to health and wellbeing from high temperatures. The annual economic costs of all climate risks will be higher

Extreme weather events are already having significant impacts:

More than 4,500 the number of deaths associated with the hottest days in England in 2022, when the temperature passed 40°C for the first time since records began

1.4 million the number of properties left without power because of Storm Eunice in 2022

£96 million the impact on the economy (lost profits) of the 2012 drought in England, according to a 2013 estimate

60% the percentage of properties at risk of surface water flooding out of all properties at risk of flooding (coastal, fluvial, groundwater and surface water) across England

Extreme weather events are likely to become more frequent and extreme as global temperatures rise:

By 2050 hot summers in the UK are projected to double in frequency and the chance of a summer as hot as 2018 (the joint hottest on record) is expected to be 50%

Summary

Introduction

1 Government assesses the most serious risks facing the UK or its interests overseas over the next few years via the National Security Risk Assessment, a classified document. Its public-facing version, the National Risk Register, includes 89 risks. Both documents identify eight extreme weather events as national risks: coastal flooding, droughts, high temperatures and heatwaves, low temperatures and snow, fluvial flooding, severe space weather, storms and surface water flooding. The third independent assessment of the UK's climate risks, issued by the Climate Change Committee (CCC) in 2021, identifies 61 risks and opportunities arising from changing climatic conditions and extreme weather events.

2 Extreme weather events are those weather events that are significantly different from the average or usual weather pattern. Extreme weather events are becoming more frequent and more extreme as global temperatures rise. Recent events, such as successive severe storms, high temperatures and droughts experienced in 2022, have highlighted the challenges that the UK faces from these risks.

3 The Cabinet Office assigns ownership of acute national risks to lead government departments (LGDs) across risk identification and risk assessment; prevention, resilience, preparation and emergency response; and recovery. The LGD may change between these phases as the impacts change and different competencies are required. For some national risks, ownership of some or all phases of the risk lifecycle is devolved to the administrations in Northern Ireland, Scotland and Wales. The National Audit Office (NAO) does not audit these administrations, and so these plans are outside the scope of this report. The UK adopts a bottom-up approach to managing emergencies as most emergencies only affect local areas. Local responders, such as the police, fire and ambulance services, manage them without the direct involvement of central government. The response to larger-scale emergencies is led by an LGD and, in the most serious cases, is coordinated through the Cabinet Office Briefing Rooms (known as 'COBR'). COBR's role is to ensure that ministers and senior officials are provided with timely, coordinated and quality advice to enable quick and efficient decision-making during national crises, to provide a focal point for the government's response and to be an authoritative source of advice for local responders.

4 The COVID-19 pandemic highlighted the need to strengthen national resilience to prepare for future emergencies that may impact the UK. Government defines resilience as "an ability to withstand or quickly recover from a difficult situation, but also to get ahead of those risks and tackle challenges before they manifest". This covers the UK's ability to anticipate, assess, prevent, mitigate, respond to and recover from known, unknown, direct, indirect and emerging risks.

5 In December 2022, government published *The UK Government Resilience Framework*, setting out its strategic approach to strengthening resilience. The framework identifies three core principles: the need for a shared understanding of the risks faced by the UK; prevention rather than cure wherever possible (as responding to events and repairing damage can be much more costly than investing in prevention and preparedness); and that developing resilience requires a 'whole of society' approach. The framework sets out the key actions that the UK government intends to undertake by 2025 or 2030 in England and in those areas where responsibilities are not devolved, across the UK. The third National Adaptation Programme, published in July 2023, also sets out a five-year programme of work across government to build resilience to climate change.

6 The NAO will be undertaking a programme of work on resilience. This report and the report *Resilience to flooding* are the first reports in this series.[1]

Scope

7 This report examines how well-prepared the country is for future extreme weather events. Given the cross-cutting nature of these risks and their impacts they require coordinated action to be taken across government and beyond. The report sets out how central government coordinates, leads, supports and assures local activity, but does not cover local responses, such as local response plans. It also does not cover arrangements in the devolved nations. It aims to answer the following questions:

- Does the UK government have a clear vision and well-defined roles and responsibilities to manage national risks, such as extreme weather events, and the generic capabilities to deal with emergencies?
- Does the UK government have a clear understanding of extreme weather events and the impacts that they can have in England?
- Has the UK government taken appropriate action to prepare for, respond to, and prevent the potential impacts of, extreme weather events in England?

1 Comptroller and Auditor General, *Resilience to flooding*, Session 2023-24, HC 189, National Audit Office, November 2023.

8 The report concludes on how well-prepared the country is for future extreme weather events. It does not cover all extreme weather events, but uses examples from four case studies (droughts, high temperatures and heatwaves, surface water flooding and storms) to set out how government manages these risks (**Figure 1** on pages 8 and 9). By using four case studies on extreme weather events, we also aim to draw out wider learning for government on improving national resilience. Appendix One sets out our audit approach and evidence base.

Key findings

Arrangements for managing national risks, such as extreme weather

9 Since 2021, government has strengthened the arrangements to manage national risks. In 2021, the Cabinet Office established the National Situation Centre to bring data, analysis and insight together to improve its ability to identify, monitor and manage risks. During the period of extreme heat in July 2022, the centre worked with partners to identify vulnerable groups and locations, helping government to target support effectively. The Cabinet Office established: a resilience directorate, which leads the government's efforts to strengthen the UK's resilience along with a new board with cross-government representation; the COBR Unit, which leads horizon-scanning for and response to acute emergencies and drives professionalisation of emergency management in government; a resilience sub-committee of the National Security Council; and the UK Resilience Forum, which brings together representatives of the public, private and third sectors to improve communication and collaboration on risk, emergency preparedness, crisis response and recovery. The Cabinet Office also appointed a Head of Resilience to provide leadership and coordination across the UK resilience system and updated the list of LGDs, providing greater clarity over responsibilities for national risks across the risk lifecycle (paragraph 1.5, and Figures 2, 3 and 5).

Figure 1

Our four case studies of extreme weather events: droughts, high temperatures and heatwaves, storms and surface water flooding

Extreme weather events can have significant impacts, affect many people and can be costly

	Droughts	High temperatures and heatwaves	Storms	Surface water flooding
Definition	Periods of water shortage caused by a period of low rainfall. Their nature, timing and impacts vary. Droughts are classified as agricultural, environmental or water supply, depending on their impacts. These three types of drought may occur separately or together. Droughts can have four stages: prolonged dry weather, drought, severe drought and recovering.	Extended periods of hot weather when a location records a period of at least three consecutive days with daily maximum temperatures meeting or exceeding the heatwave temperature threshold. This varies by UK county from 25°C to 28°C.	Deep and active areas of low pressure with strong winds and precipitation. Storms are named if they have the potential to cause an amber or red National Severe Weather Warning.	Surface water flooding occurs when rainfall overwhelms the capacity of drainage systems and water flows over the land instead of through drainage systems.
Recent events	A drought was declared in August 2022. By September 2022, 11 out of 14 Environment Agency areas in England were in drought. In early 2023, two areas remained in drought.	In the UK there have been heatwaves in four of the last five years. The summer of 2018 was the joint hottest on record. The 2022 heatwave was unprecedented, with temperatures exceeding 40°C for the first time.	In 2021-22, the Met Office named six storms, with some of the highest wind speeds recorded in more than 30 years. Storm Eunice left 1.4 million homes without power and Storm Arwen left more than 1 million customers without access to mobile and fixed-line connections.	In July 2021, widespread flooding affected three-quarters of London's boroughs, with 1,500 properties flooded. It affected homes, businesses, health infrastructure and transport networks.
Future likelihood	As global temperatures rise, there is a risk that droughts will become more frequent in the UK. Droughts are expected to become more severe.	The likelihood and intensity of high temperature episodes is increasing. By 2050, hot summers in the UK are projected to at least double in frequency and the chance of a summer as hot as 2018 is expected to be 50%.	The evidence base for increased storminess is weak.	Evidence is building that heavy rainfall events are becoming more frequent and intense.
Who could be affected	Can affect significant parts of the UK.	Can affect significant parts of the UK. Urban areas are more at risk because man-made structures absorb more heat than natural landscapes.	Can affect significant parts of the UK. Northern areas are more likely to be affected.	Across England, of the 5.7 million properties at risk of coastal, fluvial, groundwater or surface water flooding, 3.4 million (60%) are at risk of surface water flooding. More than 365,000 properties are in areas at high risk of surface water flooding.
Costs and deaths	The economic costs of the 2012 drought in England were £165 million in revenues and £96 million in profits, based on a 2013 estimate.	The estimated productivity loss in the 2010 heatwave was £770 million. More than 4,500 heat-related deaths were recorded during the summer of 2022 in England.	Estimated insurance losses of £250 million to £300 million for Storm Arwen and £200 million to £350 million for Storm Eunice. Storm Arwen caused three deaths, Storm Eunice caused four deaths and Storm Babet in 2023 caused seven deaths.	The July 2021 London floods resulted in estimated insurance losses of £281 million and no deaths.
Common types of impact	**Agricultural**: impact on crop production or farming practices such as spray irrigation, impacting agricultural production. **Environmental**: reduced river flows, exceptionally low groundwater levels and insufficient moisture within soil. This results in stress for wildlife, fish and habitats, environmental damage and increased wildfire risk. **Infrastructure**: ground shrinkage affecting some roads and parts of the rail network. **Water supply**: shortages and restrictions impacting individuals, industry and businesses.	**Health**: excess deaths, increased risk of sunburn, heatstroke and other heat-related illnesses. **Environmental**: stress for plants and animals. **Infrastructure**: disruption to transport networks, supply chains, power and water supplies. **Social and economic**: likely disruption as behaviours change, including working patterns and levels of productivity.	**Health**: casualties and fatalities. **Environmental**: fallen trees. **Infrastructure and economic**: disruption to power, communications and transport networks; damage to homes, businesses and other properties.	**Health**: casualties and fatalities. **Environmental**: polluted watercourses. **Infrastructure and economic**: damage to homes and businesses; disruption to transport and services (such as hospitals, schools, prisons and courts).

Source: National Audit Office review of literature on extreme weather events

10 Government has yet to set out how resilient it would like the UK to be, either to all risks in aggregate or to most specific risks. Stakeholders, such as government resilience practitioners, the National Infrastructure Commission and the CCC, have welcomed *The UK Government Resilience Framework*. They regard its three principles for strengthening resilience and supporting actions as positive first steps. However, the framework does not set out a well-defined vision for what a resilient UK looks like, including targets and standards for the desired level of national, local or sectoral resilience. For three of the four extreme weather risks we examined (all except drought), government has not specified what outcome it is looking to achieve, such as target levels of preparedness or resilience, or the amount of risk that it is willing to accept in the pursuit of those outcomes (risk appetite). Without these, government cannot make informed decisions about trade-offs between long- and short-term priorities, investment or funding allocation of priority areas. It also makes it difficult for government or other stakeholders to track progress and evaluate how effectively and efficiently government is using public funds to improve national resilience. The Cabinet Office told us that it is developing options for different levels of investment that government may commit to specific response capabilities, depending on its risk appetite and tolerance (paragraphs 1.6 and 3.2).

11 Instead, government focuses on common consequences of risks and the ability to respond via generic capabilities, as well as planning for specific risks where this will make the most difference. This is informed by a number of sources, including the National Security Risk Assessment, new chronic risk analysis planned to provide evidence on potential future risk trajectories, capabilities assessments (see paragraph 14), assessments of the resilience and interdependencies of critical national infrastructure sectors and lessons from the National Exercising Programme (see paragraph 24). Cabinet Office told us this will be used to take a view on what level of preparedness is appropriate, what level of risk is acceptable and to make investment decisions (paragraphs 1.11 to 1.13).

12 Government is taking steps to address extreme weather risks as whole-system risks but could do more to strengthen assurance arrangements. Although single or multiple LGDs have ownership for each extreme weather risk, to manage these risks and build resilience to them requires coordinated action to be taken across government and beyond. This can be challenging for individual departments to coordinate and oversee. For example, commenting in March 2023 on previous adaptation programmes, the CCC has noted the lack of progress being made by government on climate adaptation, for which the lead department in England is the Department for Environment Food & Rural Affairs (Defra). To address this, the Cabinet Office and Defra, working with HM Treasury, has established a senior-level Climate Resilience Board. The Board aims to oversee strategic, cross-cutting climate adaptation and resilience issues and drive government action to increase UK resilience to climate change (paragraphs 1.17 and 1.18, and Figure 6).

13 Some roles and responsibilities for managing risks are still not clear. Although government has identified that developing resilience requires a 'whole of society' approach, it has yet to set out the respective roles of central government, local government, the devolved administrations, the private and voluntary sectors, and the public, leading to uncertainty on what actions to take. Regulation can play an important role in helping to manage risks but not all regulators have a remit for climate resilience, including extreme weather events (see paragraph 25). In addition, for some individual risks, such as surface water flooding, it is not always clear who the public should contact when an event occurs (paragraphs 1.7, 3.9 and 3.19).

14 The Cabinet Office's latest assessment of central government's preparedness is due to conclude by the end of 2023. The Cabinet Office draws together the common consequences of national risks, such as disruption to critical national infrastructure and casualties, to form 25 national resilience planning assumptions. These set the benchmarks for the generic capabilities, such as dealing with disruptions to critical national infrastructure, that should be in place for the UK to be prepared adequately to deal with most emergency scenarios. The Cabinet Office is running an assessment of the central government's capabilities to determine the UK's current level of preparedness and any gaps in its ability to respond to these risks, which is due to be completed by the end of 2023 (paragraphs 1.11 to 1.13).

Understanding of extreme weather events and their impact

15 Government has good forecasting data for droughts, heatwaves and storms, but less so for surface water flooding. Weather forecast data, climate change modelling data and risk assessment data are available and shared widely to inform decision-making and risk management. For example, the Met Office provides short-, medium- and long-range weather forecasts and issues weather warnings when severe weather has the potential to impact the UK. Surface water floods are the exception. Currently, it is difficult to predict the precise location, timing and impact of these events due to their localised nature and because they normally happen very quickly. The Met Office is due to carry out further modelling work on localised heavy rainfall in 2024 (paragraphs 2.2, 2.3 and 2.5).

16 Government continues to develop its understanding of extreme weather impacts from previous events but lacks information on less common events. Government has less data on how high temperatures and heatwaves will impact the UK because it has limited experience of this type of event. For example, some of the effects of longer periods of high temperatures on different sectors and infrastructure were unknown until the record-breaking temperatures experienced in July 2022. Government has announced several pieces of work to better understand the impacts of extreme heat. Our 2021 report on government's preparedness for the COVID-19 pandemic highlighted the need for government to promptly share and implement lessons from exercises.[2] The Cabinet Office now produces a regular UK Resilience Lessons Digest, which summarises lessons from a range of sources to share insights across government and wider partners. For example, the first issue in October 2022 shared lessons from Storm Arwen in 2021. Government regularly carries out exercises and applies the learning from these. While government arrangements for recovering from emergencies recommend that lessons should be identified and shared for the benefit of those who might be involved in future emergencies, we saw less evidence of government implementing learning from actual events (paragraphs 2.4 and 3.5, and Figure 8).

17 Government does not yet have a good understanding of the interaction between different risks, the further impacts that this can have and how risks in one system can have knock-on effects in another system. For example, the July 2022 heatwave resulted in failures at two data centres used to host the IT systems of a London hospital. This caused widespread disruption to patient care and clinical services, including to hospitals in the area to which patients were diverted. During Storm Arwen, in November 2021, problems with the power network affected communication networks and people's ability to access emergency services: households without power had no way of contacting emergency services because their phone lines were reliant on electricity to work. Mapping and understanding these interconnections can help to manage these risks as a system, which is only as strong as its weakest link. The Cabinet Office is working with departments to map critical national infrastructure assets and the interdependencies between them to inform risk mitigation and planning. It aims to complete the first phase of this work by the end of 2023 (paragraphs 2.7 and 2.8).

2 Comptroller and Auditor General, *The government's preparedness for the COVID-19 pandemic: lessons for government on risk management*, Session 2021-22, HC 735, National Audit Office, November 2021.

18 Government produces 'reasonable worst-case scenarios', but some recent events have exceeded planning assumptions. Considering multiple scenarios can help to plan and identify the different response capabilities that might be needed. Storm Arwen in November 2021 exceeded the planning assumptions of those scenarios, such as expected customer call volumes, because its atypical northerly wind direction caused more damage than wind gusts coming from the prevailing south-west would have done. The review that followed recommended updating the reasonable worst-case scenarios against which response plans could be tested and providing updated planning assumptions for other sectors to plan against (paragraphs 2.9 to 2.13).

19 Adaptation action can help to reduce the future costs of these events. Analysis for the CCC indicates that at least eight climate change risks may each have a cost of more than £1 billion a year by 2050. These include risks to businesses from flooding and risks to health and wellbeing from high temperatures. An evidence base is also building of the economic benefits of many adaptation actions. For example, analysis undertaken for the CCC indicates the average benefit to cost ratios for the following measures were: water efficiency measures (11:1), heat alert and heatwave planning (10.5:1), weather and climate services including early warning (9:1), and flood preparedness and protection (6:1) (paragraph 2.14).

Action to prevent, prepare for, and respond to the potential impacts of extreme weather events

20 Government has dedicated response arrangements in place for extreme weather events. These provide it with the means to monitor events and the response to them and consider where central government support and actions may assist. Processes in place include established escalation protocols, with clearly defined roles and responsibilities across policy and communications; close working with forecasters and government agencies, such as the Met Office and the Flood Forecasting Centre to inform planning and risk assessments; and regular reviews and testing of plans. Government and the response community undertake reviews of significant events to learn lessons, to be better prepared for the next ones (paragraph 3.5, and Figures 6 and 7).

21 The CCC has found little evidence that government is driving adaptation at the pace and scale needed to fully prepare for climate risks facing the UK. Government has undertaken a range of activities to develop resilience to future extreme weather events, such as updating building regulations and investing £5.2 billion in flood defences. However, the CCC's 2023 report to Parliament on progress in adapting to climate change found very limited evidence of the implementation of adaptation at the scale needed to fully prepare for climate risks facing the UK across cities, communities, infrastructure, economy and ecosystems. It, along with the National Infrastructure Commission, has highlighted that infrastructure, such as roads, rail, power and data centres, is not designed to withstand extreme weather events, particularly high temperatures and heatwaves (paragraphs 3.25 and 3.26).

22 Government has committed to developing a coordinated approach to investment in resilience, but this approach may not be ready until 2030. Government does not know how much the public sector is spending to manage extreme weather risks because action is taken across a wide range of organisations. There is no common definition of what constitutes resilience activity, so this figure would be difficult to calculate. We found little evidence across our case studies that risk assessment was feeding into funding decisions. Government notes that to make strategic investment decisions, it needs to understand how current capabilities match up with risks and concentrate investment where gaps are identified. As a first step, it aims to agree a working definition of resilience activities and capabilities, and using that, map current government resilience capabilities. It also plans to start measuring and tracking departmental investment in resilience across national risks, meaning risk-owning departments will be able to track investments, which should help support the coordination and prioritisation of investments (paragraphs 3.12 and 3.13).

23 Government has done less to encourage private sector investment in resilience to extreme weather events and climate change than on other long-term challenges such as net zero. Both public and private sector investment has a critical role in developing national resilience to extreme weather events and climate change. Many flood defence projects require funding to be secured from public and private sector sources in addition to government funding before they can go ahead.[3] Defra has not set a target for how much of this additional funding should come from the private sector and, to date, only 9% has been from the private sector. The 2023 Green Finance Strategy highlights government's intention to take action to prepare the UK for the physical impacts of the changing climate, to seek to align financial flows with a climate-resilient economy, and to increase investment in adaptation. However, government action to create the right environment for adaptation lags behind that for net zero. For example, when compared with the strategy's commitments on net zero and nature, commitments on adaptation are substantially weaker; there is a lack of concrete goals and actions, milestones and plans to address the key barriers to adaptation; and there is a lack of scale and urgency in action compared with the magnitude and proximity of the risks (paragraphs 3.14 and 3.15).

3 Comptroller and Auditor General, *Resilience to flooding*, Session 2023-24, HC 189, National Audit Office, November 2023.

24 We found limited evidence that government tests and assures contingency plans. It is important that government gains assurance that contingency plans are fit for purpose for those risks that are managed by a wide range of organisations, many outside government's direct control. It can gain assurance by reviewing and approving plans and testing them through simulation exercises. While government tests some contingency plans through exercises carried out at the local, departmental and national levels, government considers it impractical to test all plans. Local resilience forums produce emergency plans, but central government has no direct oversight of these plans and does not assure them. Following a hiatus due to EU Exit and the COVID-19 pandemic, the Cabinet Office has restarted the National Exercising Programme. National exercises bring together key partners (including local government) to embed lessons; stress-test government's plans, structures and skills; and test government's ability to respond to risks that affect the whole of society (paragraphs 3.3, 3.4 and 3.6).

25 Regulation and standards are important tools to support the development of resilience to extreme weather events but government's use of these tools is currently limited. Some regulators, including Ofgem and Ofcom, do not have a statutory climate resilience remit. By comparison, Ofwat's duties include securing the long-term resilience of water companies' water supply and wastewater systems against climate change, using a range of regulatory tools including the price review process. Some standards for climate resilience are in place in sectors such as the water, rail and road industries. However, many sectors lack resilience standards. For example, while the energy sector has standards on recovering power after extreme weather, resilience against floods and incident recovery, most of these standards do not set a measurable level for resilience against climate change. Government has committed to new standards for resilience by 2030 (paragraphs 3.7 to 3.11).

26 Government can do more to ensure that alerts reach individuals at risk in good time. The Met Office undertakes a range of activities, including issuing severe weather warnings, to help the public make informed decisions about day-to-day activities and actions they can take to reduce potential impact. Government recently tested a new system of emergency alerts, that it plans to use to get urgent messages quickly to mobile phones when there is a risk to life and provide clear instructions about how best to respond. The public can sign up for flood warnings from the Environment Agency including fluvial, coastal and groundwater flooding, but not surface water flooding. Surveys show that public awareness of the risk of surface water flooding is low and that people do not know who to report these incidents to when they happen (paragraphs 3.17 and 3.19).

Concluding remarks

27 Extreme weather events can have devastating consequences for individuals, communities and businesses. Recent events have shown that government must do more to help prepare for and develop resilience to extreme weather. Government continues to strengthen the arrangements in place to manage these risks. However, for the extreme weather risks we examined, government has yet to set out what outcome it is looking to achieve in managing these risks and the amount of risk that it is willing to accept in the pursuit of those outcomes (risk appetite). Government does not know how much is being spent on managing extreme weather risks. Without this information it is difficult to conclude on whether its current approach represents value for money.

28 Extreme weather is becoming more frequent and severe. Government needs to increase its focus on reducing these risks and making the system more resilient to the worsening impacts of extreme weather. Given the dynamic nature of risks over the medium- and long-term, even where government makes improvements, they may not be keeping pace with changes in climate risk. The challenge for government now is how it places sufficient emphasis on prevention and preparedness, making informed decisions about prioritisation to ensure efficient and effective investment in the long-term.

Recommendations

29 Our recommendations focus on managing extreme weather events but note where they are relevant to managing risk more widely.

a **The Cabinet Office, working with other departments, should strengthen leadership, accountability and assurance arrangements for the management of extreme weather risks**. This could build on the new Climate Resilience Board that will oversee strategic, cross-cutting climate adaptation and resilience issues. It needs to cover the whole risk lifecycle and prevention activity, across government to ensure action is taken where needed. This recommendation could equally apply to other national and cross-cutting risks that require cross-government action.

b **The Cabinet Office should review the current risk and resilience structures and identify any gaps in its system-wide oversight of national risks.** Once this review is completed it should consider how to address any gaps identified, including consideration of the merits of a Chief Risk Adviser.

c **The Cabinet Office should set out what a resilient UK looks like, a strategy to deliver this, and the specific roles of government, the private and voluntary sectors and the public.** The Cabinet Office, working with LGDs should:

- assess the current level of risk and how that risk is changing over time;
- decide what is the tolerable and acceptable level for that risk (or sets of similar risks) and set out 'what good looks like' now and in the future;
- identify the gap between this and the current performance and position;
- produce costed long-term plans, in which there is a high degree of confidence in delivery, for how to drive down the risk to an acceptable level;
- bring this information together for a coordinated and prioritised approach to investment (see recommendation e); and
- monitor and track the progress in driving down the risk to the acceptable level.

d **LGDs, working with the Cabinet Office, should develop a set of resilience standards for infrastructure and give regulators consistent climate resilience roles.** Government has already committed to improve standards for resilience by 2030. It should set out a pathway to deliver these standards. Giving regulators consistent roles would enable greater coordination across regulators to improve resilience across sectors.

e **The Cabinet Office, working with HM Treasury and other departments, should develop a coordinated, prioritised approach to investment in climate and wider resilience by 2025, and implement it by 2028.** While government has committed to developing this approach by 2030, it should bring forward its delivery as a coordinated, prioritised approach is urgently needed to ensure that investment in resilience is cost-effective and achieves the greatest benefits.

f **LGDs, working with HM Treasury and the Cabinet Office, should encourage greater investment in climate adaptation from the private sector.** This might involve publicising the benefits the private sector derives from adaptation, expanding the use of UK green gilts or introducing similar financial instruments to mobilise private sector resources for climate adaptation; and facilitating risk-sharing by expanding the scope of risk-pooling arrangements. The private sector has a pivotal role to play in managing extreme weather risk and other risks related to climate change.

Part One

The UK government's arrangements to manage national risks

1.1 Extreme weather events are those weather events that are significantly different from the average or usual weather pattern. These events are becoming more frequent and more extreme as global temperatures rise. Recent events, such as the storms, high temperatures and droughts experienced in 2022, have highlighted the challenges that the UK faces from these events. This report examines the overall management of these risks, drawing on case studies of four types of extreme weather event: droughts, high temperatures and heatwaves, storms and surface water flooding. These events can affect many people, homes and businesses and have significant costs (see Figure 1).

1.2 This part assesses whether the UK government has a clear vision and well-defined roles and responsibilities to manage national risks, such as extreme weather events, and the generic capabilities to deal with emergencies. It covers:

- government's vision for national resilience;
- national assessment of risk;
- emergency planning; and
- extreme weather risks.

National resilience

1.3 Government defines resilience as the ability to withstand or quickly recover from a difficult situation, but also to get ahead of risks and tackle challenges before they manifest. This definition covers the UK's ability to anticipate, assess, prevent, mitigate, respond to and recover from known, unknown, direct, indirect and emerging risks.[4] A wide range of stakeholders are involved in building national resilience (**Figure 2** on pages 20 and 21).

4 HM Government, *The UK Government Resilience Framework*, December 2022.

1.4 The COVID-19 pandemic highlighted the need to strengthen national resilience to prepare for emergencies that may affect the UK. In late 2022, government published *The UK Government Resilience Framework*, setting out its strategic approach to strengthening resilience.[5] The Framework identifies three principles:

- the need for a shared understanding of the risks faced by the UK;
- prevention rather than cure wherever possible; and
- that developing resilience requires a 'whole of society' approach.

1.5 The Framework sets out the key actions that the UK government intends to undertake for both its UK-wide and England-specific responsibilities by 2025 or by 2030 (**Figure 3** on pages 22 and 23). To implement these measures, the Cabinet Office established:

- the **Resilience Directorate**, which leads the government's efforts to strengthen the UK's resilience;
- the **COBR Unit**, which leads horizon-scanning for and response to acute emergencies and drives professionalisation of emergency management in government;
- a cross-government **Resilience Steering Board**;
- a **resilience sub-committee** of the National Security Council; and
- the **UK Resilience Forum**, which brings together representatives of the public, private and third sectors to improve communication and collaboration on risk, emergency preparedness, crisis response and recovery.

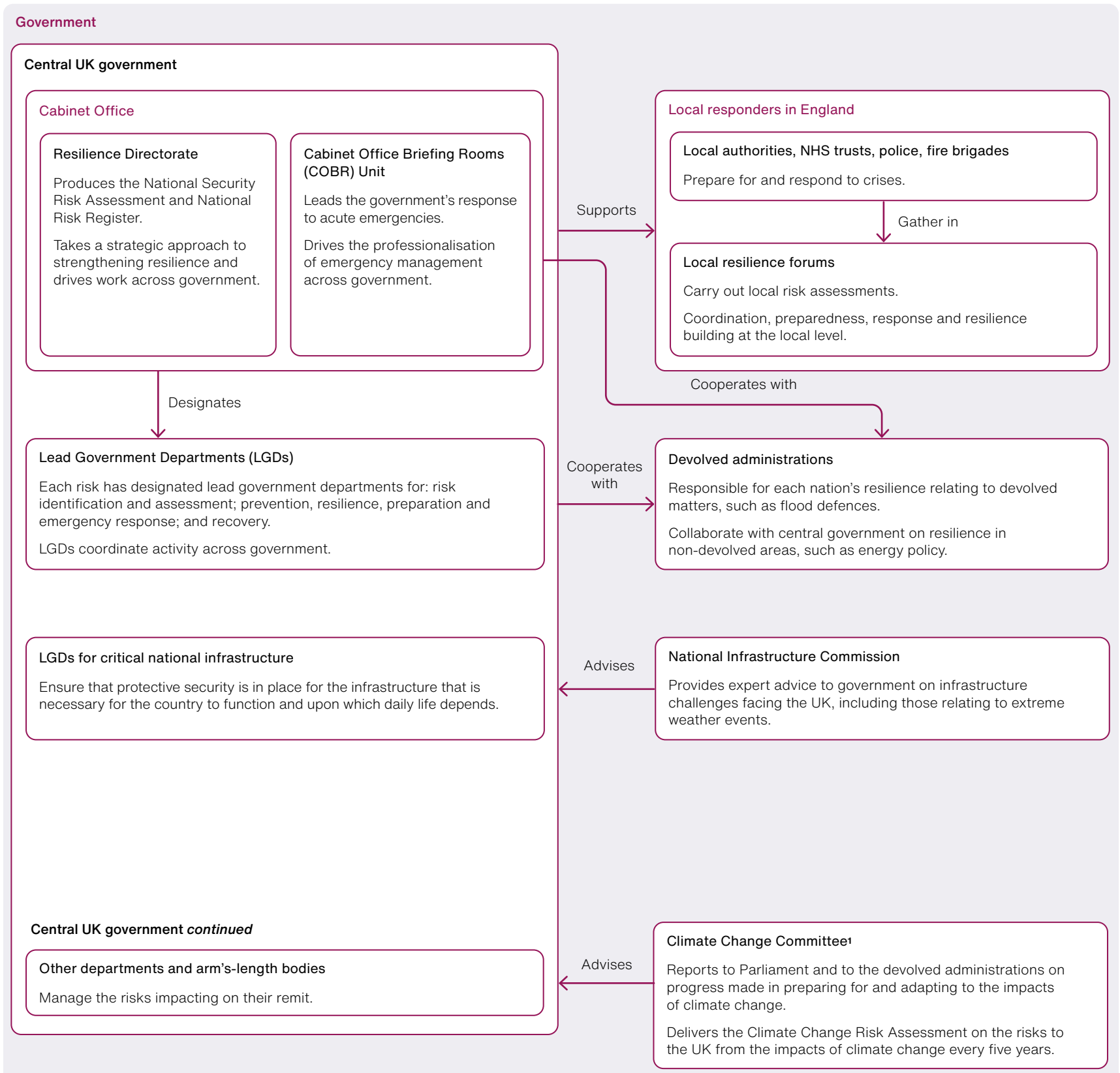
The Cabinet Office also appointed a **Head of Resilience** to provide leadership and coordination across the UK resilience system and to set and drive the strategy on building resilience.

1.6 Government has yet to set out what a resilient UK looks like collectively. Stakeholders, such as government resilience practitioners, the National Infrastructure Commission and the Climate Change Committee (CCC), have welcomed the Framework, its three principles and supporting actions as a positive first step. However, the Framework does not set out a well-defined vision for what a resilient UK looks like, nor targets and standards for the desired level of national, local or sectoral resilience.

5 HM Government, *The UK Government Resilience Framework*, December 2022.

Figure 2
Who is involved in ensuring national resilience

Central government supports, cooperates with, and communicates to, a wide range of stakeholders with the aim of ensuring that the UK is resilient to shocks



Note

1 The Climate Change Committee also advises the UK and devolved governments on emissions targets and reports to Parliament on progress made in reducing greenhouse gas emissions.

Source: National Audit Office review of literature on government bodies, including executive agencies, and on resilience

Figure 3

Examples of measures in *The UK Government Resilience Framework*, December 2022

Government has committed to a range of actions to strengthen national resilience

Theme	Examples of action taken or being undertaken	Actions committed to
Risk	Refreshed the National Security Risk Assessment (NSRA) process, with the latest version (2022) based on a new methodology. Established a new Head of Resilience, to guide best practice, encourage adherence to standards and set guidance. Issued the 2023 National Risk Register, which declassified more risk information than previous editions.	By 2025: • Clarifying roles and responsibilities for each NSRA risk (completed). • Conducting an annual survey of public perceptions of risk, resilience and preparedness. • Introducing an annual statement to Parliament on civil contingencies risk and government's performance on resilience (due in autumn 2023). • Developing a measure of social vulnerability as an indicator of socio-economic resilience and how risks impact across communities and vulnerable groups. By 2030: • Making government's communications on risk more relevant and easily accessible.
Roles and responsibilities	Established the Resilience Directorate in the Cabinet Office to work alongside government's crisis management infrastructure. The Directorate coordinates the implementation of the Resilience Framework and assigns lead government department responsibilities.	By 2025: • Expanding the scope and use of standards and assurance in the public sector. • Running a pilot across three key pillars of reform (leadership, accountability, and integration of resilience into the UK's levelling-up mission) to strengthen local resilience forums (LRFs) in England. By 2030: • Expand the scope and use of standards and assurance in the public sector to support better contingency planning and risk management.
Partnerships	Continuing to take international, bilateral and multilateral action and cooperation on risk and resilience. Continuing to use government's international action to identify and tackle risks before they manifest.	By 2025: • Growing government's advisory groups (experts, academics and industry experts) to inform the NSRA. By 2030: • Introducing standards on resilience across the private sector, where these do not already exist. • Providing better guidance on resilience to support private sector planning and risk management. • Creating common resilience standards for critical national infrastructure (CNI) and doing more on the assurance of CNI preparedness. • Reviewing existing regulatory regimes on resilience to ensure they are fit for purpose. Consider enforcing standards through regulation for the highest priority sectors not already regulated and the highest priority risks.

Figure 3 *continued*
Examples of measures in *The UK Government Resilience Framework*, December 2022

Theme	Examples of action taken or being undertaken	Actions committed to
Communities	Continuing to strengthen relationships with the Voluntary and Community Sector (VCS).	By 2025: • Offering further guidance, developed with the VCS, to LRFs and local partners in England, to support them working with vulnerable groups.
Investment	Establishing a shared understanding of risk based on risk assessments and departmental engagement to support government's investment in resilience.	By 2030: • Having a coordinated and prioritised approach to investment in resilience across government, informed by a shared understanding of risk. • Considering options for funding models for any future expanded responsibilities and expectations of LRFs. • Offering new guidance to community organisations and the public, to help them make more informed decisions about investing in their own resilience and preparedness.
Skills	Started work to develop government's vision for the UK Resilience Academy. Launched the Crisis Management Excellence Programme.	By 2025: • Delivering a new UK Resilience Academy and a new training and skills pathway to support careers in resilience. • Reinvigorating the National Exercising Programme to test plans, structures and skills.

Note
1 The Framework primarily outlines actions for England and the UK government in areas where responsibilities are reserved to the UK government. Where elements of the resilience system are overseen by the UK government, it works in partnership with the devolved administrations in Northern Ireland, Scotland and Wales.

Source: Cabinet Office, *The UK Government Resilience Framework*, December 2022

1.7 Although the Framework has highlighted that developing resilience requires a 'whole of society' approach, government has yet to set out what the respective roles of central government, local government, the devolved administrations, the private and voluntary sectors, and the public are, leading to uncertainty on what actions to take. Internationally, the Australian government has issued statements of responsibilities for government, business, third sector and individuals.

National assessment of risk

1.8 Government assesses the most serious risks facing the UK or its interests overseas via the classified National Security Risk Assessment (the Assessment). It covers areas such as natural hazards, accidents, human and animal health risks, societal risks, terrorism and state threats. The latest Assessment was issued in 2022. The Cabinet Office coordinates the production of the Assessment and its public-facing version, the National Risk Register (the Register), working closely with a wide range of stakeholders. The Register includes 89 risks, of which eight are extreme weather events (**Figure 4**).

1.9 The Cabinet Office assigns ownership in England of national risks to lead government departments (LGDs) across three phases (**Figure 5** on page 26):

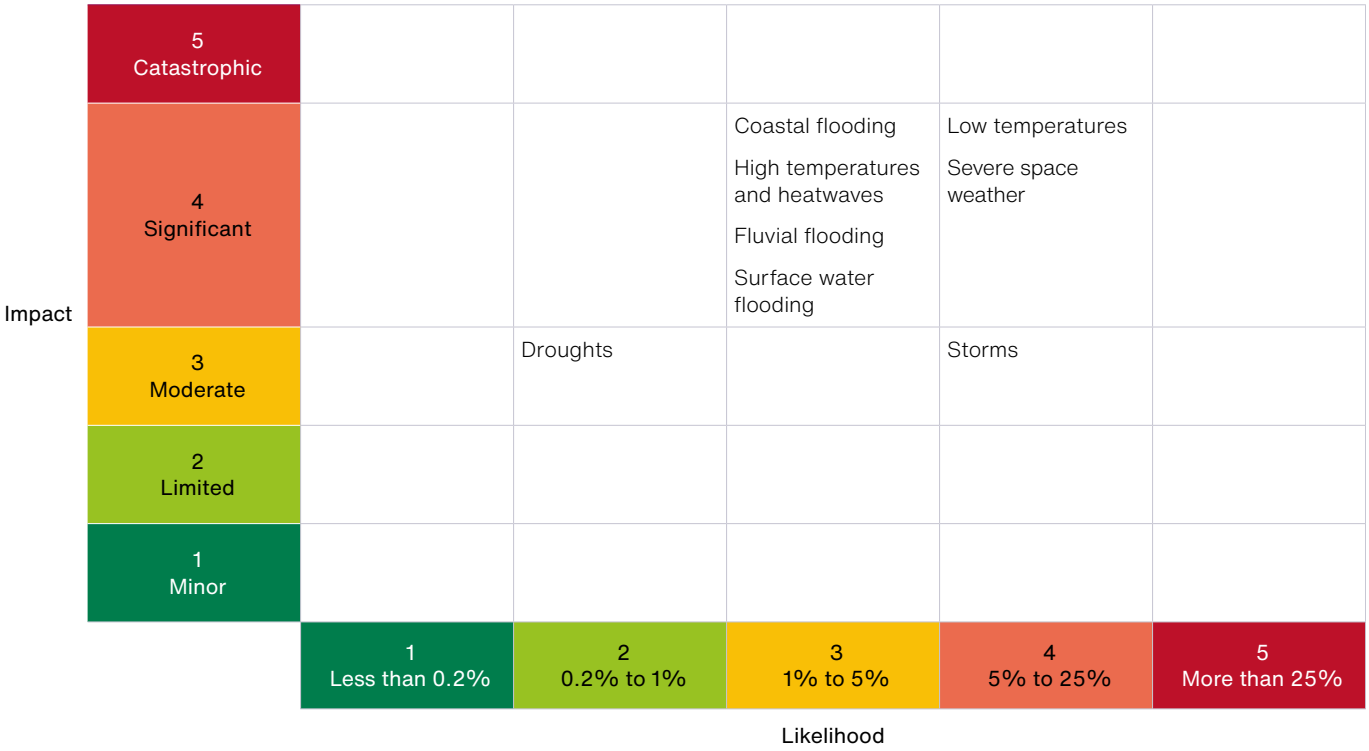
- risk identification and risk assessment;
- prevention/resilience, preparation and emergency response; and
- recovery.

The LGD may change between these phases as the impacts change and different competencies are required. While the LGD model has been in place since 2002, a specific responsibility for building resilience and preventing risks from occurring was introduced in 2023. Other countries, such as Australia, have one government agency responsible for emergency response, recovery and resilience (see Appendix Two).

Figure 4

The UK government's national assessment of extreme weather risks, 2023

Of the 89 risks identified in the 2023 National Risk Register, eight are extreme weather events



Notes

1 The National Security Risk Assessment, on which the National Risk Register is based, assesses the impact of the reasonable worst-case scenario of each risk across seven dimensions: human welfare, behavioural, economic, essential services, environment, security and international. Each dimension comprises multiple indicators.

2 Likelihood is represented as the percentage chance of the reasonable worst-case scenario of the risk occurring at least once within the assessment timescale. The assessment timescale is two years for malicious risks and five years for non-malicious risks. Malicious risks originate from people who seek to do harm to the UK or its citizens. Non-malicious risk covers risks such as accidents or natural hazards.

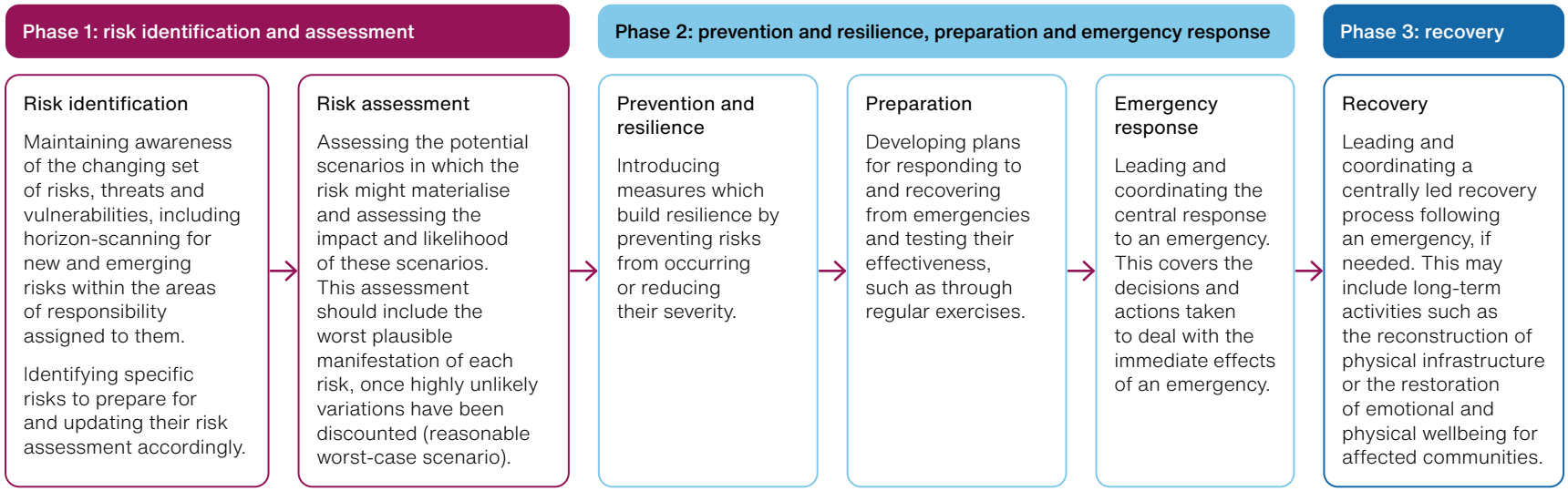
3 The reasonable worst-case scenario represented in the diagram for our four case studies are: large parts of South and East England facing severe drought conditions after three consecutive dry winters; extended period of high temperatures and would affect 50% to 70% of the UK population and take place over five consecutive days, with maximum temperatures exceeding 35°C; a large flood event in a metropolitan area, resulting from a pocket of exceptionally high rainfall in the south east; and storm force winds affecting multiple regions of the UK for at least six hours during a working day.

Source: National Audit Office analysis of Cabinet Office, *National Risk Register: 2023 edition,* August 2023

Figure 5

Responsibilities of lead government departments (LGDs) for national risks

LGDs are responsible for leading work to identify risks and ensuring that the right planning, response and recovery arrangements are in place



Notes

1 LGDs are supported by other departments and government bodies, including executive agencies, in delivering these responsibilities.

2 The Cabinet Office clarified the roles and responsibilities of LGDs in July 2023. Prior to this, the LGDs for Phase 2 were responsible for planning and emergency response only.

3 Ownership of some risks or some phases of the risk lifecycle are devolved to the administrations in Northern Ireland, Scotland and Wales.

Source: National Audit Office analysis of Cabinet Office, *The Roles of Lead Government Departments, Devolved Administrations and Other Public Bodies*, August 2023

1.10 The latest Assessment (2022) and Register (2023) reflect changes resulting from a substantial government review of the risk assessment process, including external review of the 2019 Assessment methodology conducted by the Royal Academy of Engineering.[6] The changes include:

- a focus on acute risks, that is, discrete events that may require an emergency response. Chronic risks, such as antimicrobial resistance, are no longer included. Chronic risks pose continuous challenges and generally manifest over a longer timeframe. While these risks also require government-led responses, these tend to be developed through strategic, operational or policy changes rather than emergency responses. The Cabinet Office is now establishing a new process for identifying and assessing chronic risks;
- longer assessment timescales: LGDs now assess non-malicious risks, such as accidents and natural hazards, over five years rather than two years; and
- aligning the structure and content of the Register with the Assessment, making more information available in the Register and improving access through a new online portal.

Emergency planning

1.11 The Cabinet Office draws together the common consequences of the risks set out in the Assessment to form 25 national resilience planning assumptions. Common consequences include casualties, disruptions to critical national infrastructure (CNI) and disruption to services, such as emergency and education services.[7] Each risk is linked to several planning assumptions. There are 12 linked planning assumptions for droughts, 16 for high temperatures and heatwaves, 17 for surface water flooding, and 18 for storms.

1.12 Planning assumptions set the benchmarks for the generic capabilities, such as dealing with disruptions to CNI, that should be in place for the UK to be prepared adequately to deal with most emergency scenarios. Government departments and agencies can use the national resilience planning assumptions to assess whether existing plans, infrastructure, equipment, supplies and training are adequate.

1.13 The Cabinet Office's latest assessment of central government's preparedness is due to conclude by the end of 2023. It assesses the effectiveness of both general response capabilities and preparations for the most serious risks. The Cabinet Office told us this will be used along with information such as the Assessment and chronic risk analysis to take a view on what level of preparedness is appropriate, what level of risk is acceptable and to make investment decisions.

6 Royal Academy of Engineering, *Building resilience: lessons from the Academy's review of the National Security Risk Assessment Methodology,* 2023.
7 In the UK there are 13 CNI sectors: chemicals, civil nuclear, communications, defence, emergency services, energy, finance, food, government, health, space, transport and water.

1.14 At the local level in England, emergency planning is primarily a responsibility of the emergency services, local authorities, health bodies and the Environment Agency, designated by the Civil Contingencies Act 2004 as category 1 responders. Responders in each local area convene in local resilience forums (LRFs), which are tasked with collectively assessing local risks, compiling community risk registers, preparing and validating emergency plans. During 2023, the Met Office became a category 2 responder within the Civil Contingencies Act. This change enables Met Office civil contingency advisers to work in a more consistent and structured way with LRFs and emergency responders during emergencies, emergency planning and training exercises.

1.15 Recent reviews recognised the need to strengthen the roles and responsibilities of LRFs, including leadership and accountability.[8] Until recently, LRFs did not receive central government funding and relied on contributions from partners. After a pilot in 2021, the Department for Levelling Up, Housing & Communities (DLUHC) agreed a £22 million three-year funding settlement for LRFs in England, starting in April 2022. As part of a separate programme, government has committed to running a pilot to 2025 across three key pillars of reform (leadership, accountability, and integration of resilience into the UK's levelling-up mission) to strengthen LRFs in England. Government has also committed to, by 2030, considering options for funding any future expanded responsibilities and expectations of LRFs.

1.16 The UK adopts a bottom-up approach to managing emergencies. As most emergencies only affect local areas, local responders, such as the police, fire and ambulance services, manage them without the direct involvement of central government. In some instances, the scale or complexity of an emergency means that some degree of central government support or coordination becomes necessary. This is led by the designated LGD. In the most serious cases, the UK government's response is coordinated through the Cabinet Office Briefing Rooms (known as 'COBR'), a Cabinet Committee that is convened when needed to deal with major crises. COBR's role is to ensure that ministers and senior officials are provided with timely, coordinated and quality advice to enable quick and efficient decision-making during national crises, to provide a focal point for the government's response and to be an authoritative source of advice for local responders.

8 For example: HM Government, *Global Britain in a Competitive Age: The Integrated Review of Security, Defence, Development and Foreign Policy*, CP 403, July 2021; Cabinet Office, *Civil Contingencies Act: Post Implementation Review 2022*, March 2022; National Preparedness Commission, *Independent review of the Civil Contingencies Act 2004 and its Supporting Arrangements,* March 2022.

Extreme weather risks

1.17 A wide range of organisations are involved in managing extreme weather risks and building resilience to these events (**Figure 6** on pages 30 to 33). Extreme weather risks are whole-system risks as they have wide-ranging impacts upon individuals, society, government and the economy. Managing these risks and building resilience to them requires coordinated action across government and beyond. For our four case studies, only drought has the same LGD for all three phases. LGDs are supported by other departments and government bodies, including executive agencies, in delivering these responsibilities.

1.18 The third independent assessment of the UK's climate risks, issued by the CCC in 2021, identifies 61 risks and opportunities arising from changing climatic conditions and extreme weather events. The National Adaptation Programme, led by the Department for Environment Food & Rural Affairs (Defra), sets out the actions that government and others will take to adapt to the challenges of climate change in England on a five-yearly cycle. Commenting in March 2023 on previous adaptation programmes, the CCC noted the lack of progress being made on climate adaption, highlighting that the next adaptation programme must have effective cross-government governance structures in place to ensure that all relevant departments are engaged and collectively own and deliver on interlinked adaptation challenges across multiple sectors.[9] To address this, *The Third National Adaptation Programme (NAP3) and the Fourth Strategy for Climate Adaptation Reporting*, published in July 2023, announced that the Cabinet Office and Defra, working with HM Treasury, would establish a senior-level Climate Resilience Board to oversee strategic, cross-cutting climate adaptation and resilience issues and drive government action to increase UK resilience to climate change.[10]

9 The CCC is an independent, statutory body established under the Climate Change Act 2008. Its role is to advise the UK and devolved governments on emissions targets and to report to Parliament on progress made in reducing greenhouse gas emissions and preparing for and adapting to the impacts of climate change.

10 HM Government, *The Third National Adaptation Programme (NAP3) and the Fourth Strategy for Climate Adaptation Reporting*, HC 1649, July 2023.

Figure 6

Organisations involved in managing extreme weather risks and the impacts that they can have in England

A wide range of organisations are involved including lead government departments (LGDs)

	Droughts	High temperatures and heatwaves	Storms	Surface water flooding
LGD for risk identification and risk assessment	Department for Environment Food & Rural Affairs (Defra): responsible for the policies relating to water resources in England.	Met Office: provides data, expert advice and consultancy to the Cabinet Office. Supports local government, emergency responders, local resilience forums (LRFs) and critical national infrastructure (CNI) owners through its network of civil contingency advisers. Issues weather warnings through its National Severe Weather Warning Service. Jointly responsible with the UK Health Security Agency (UKHSA) for delivering a new dedicated platform for Weather-Health Alerts from April 2023.[3]	Met Office: provides data, expert advice and consultancy to the Cabinet Office. Supports local government, emergency responders, LRFs and CNI owners through its network of civil contingency advisers. Issues weather warnings through its National Severe Weather Warning Service. Names storms.	Defra: responsible for policy direction, providing funding and guidance.
LGD for prevention/ resilience, preparation and emergency response	Defra	For impacts on: • Health: Department of Health & Social Care (DHSC). • Aviation, rail, roads and ports: Department for Transport (DfT). • Energy: Department for Energy Security & Net Zero (DESNZ). • Buildings: Department for Levelling Up, Housing & Communities (DLUHC). • Telecommunications: Department for Science, Innovation & Technology (DSIT).	For impacts on: • Health: DHSC. • Aviation, rail, roads and ports: DfT. • Energy: DESNZ. • Buildings: DLUHC. • Telecommunications: DSIT.	Defra
LGD for recovery	Defra			DLUHC
Cabinet Office	Decides whether the Cabinet Office Briefing Rooms (COBR) is required to coordinate the national response to severe drought (in consultation with the LGD). May convene COBR in advance to take stock of the national picture and to ensure adequate preparatory action is taking place across government.	Assumes LGD status for COBR-level heat response as per the UK Extreme Heat Escalation Protocol.[4] Coordinates from the outset, where cross-cutting impacts are anticipated. Convenes the Summer Resilience Network when necessary.[5]	Assumes LGD status for COBR-level storm response. Coordinates from the outset, where cross-cutting impacts are anticipated. Convenes the Winter Resilience Network when necessary.[5]	Decides whether activation of the National Flood Response Centre (co-owned with Defra), or in the most severe instances, COBR is required to coordinate the response to a major incident (in consultation with the LGD).

Figure 6 *continued*
Organisations involved in managing extreme weather risks and the impacts that they can have in England

	Droughts	High temperatures and heatwaves	Storms	Surface water flooding
Other organisations (examples)	**Environment Agency (EA):** provides strategic oversight and is responsible for monitoring, reporting, advising and acting to reduce the impact of a drought on the environment and water users. **National Drought Group** (senior decision-makers from government and the sectors impacted by drought): produce a cross-sector view of national drought issues. Coordinates the delivery of drought management activities, communications, and risk mitigation. **Natural England (NE):** provides advice and expertise on how a drought is affecting protected habitats, species and the natural environment to government, industries, farmers, local communities and interest groups. NE may restrict access to some areas if there is a risk of fire caused by dry conditions. NE has a statutory duty for the Countryside Code and associated rapid publicity campaigns in relation to extreme weather events, including drought. **UKHSA:** Implementation of the Adverse Weather and Health Plan.[6] UKHSA provides public guidance and information on the potential health impacts of drought in England.	**UKHSA:** responsible for developing, reviewing and supporting the implementation of the Adverse Weather and Health Plan and associated guidance and evidence, and for managing the weather and health early warning system. **Transport network operators:** responsible for maintaining transport network resilience. **Water companies:** responsible for managing water supply for their customers and taking measures to maintain supplies, while minimising environmental impact. **NE:** provides advice and expertise on how a heatwave is affecting protected habitats, species and the natural environment to government, industries, farmers, local communities and interest groups. NE may restrict access to some areas if there is a risk of fire caused by hot dry conditions. NE has a statutory duty for the Countryside Code and associated rapid publicity campaigns in relation to extreme weather events, including heatwaves.	**Electricity network operators:** responsible for maintaining electricity network resilience. **Transport network operators:** responsible for maintaining transport network resilience. **NE:** provides advice and expertise on recovery activities after storms for marine and terrestrial habitats to government, industries, farmers, local communities and interest groups.	**EA:** responsible for supervision of all matters related to flood and coastal erosion management and providing strategic leadership for the management of flooding from all sources, including surface water and coastal change. It has discretionary powers to provide and operate flood warning systems in relation to all sources of flooding, including surface water. Runs the Flood Forecasting Centre jointly with the Met Office. Manages central government grants for capital projects carried out by local authorities and internal drainage boards. **Regional flood and coastal committees:** responsible for ensuring plans are in place for managing flood and coastal erosion risks, promoting investment in flood risk management and providing a link between flood risk management authorities and other relevant bodies. **Lead local flood authorities (unitary authorities and county councils):** lead in managing local flood risks, including preparing and maintaining a strategy for local flood risk, carrying out works to manage local flood risks and playing a lead role in emergency planning and recovery after a flood event. **Flood risk management authorities** also include internal drainage boards, highways authorities, water and sewerage companies. **NE:** provides advice and expertise on recovery activities after floods of protected habitats to government, industries, farmers, local communities and interest groups. NE has a statutory duty for the Countryside Code and associated rapid publicity campaigns in relation to extreme weather events, including flood. **UKHSA:** Implementation of the Adverse Weather and Health Plan. UKHSA provides public and front-line responders guidance on the potential health impacts of flooding in England.
Local resilience forums (LRFs)	Include the National Security Risk Assessment risks of greatest impact to their local area in their community risk registers. Extreme weather events may feature in their emergency plans. LRFs should respond when extreme weather events impact their area. Met Office advisers and DLUHC government liaison officers work with LRFs.		Include the National Security Risk Assessment risks of greatest impact to their local area in their community risk registers. Extreme weather events may feature in their emergency plans. LRFs should respond when extreme weather events impact their area. Met Office advisers and DLUHC government liaison officers work with LRFs.	

Notes

1 This figure does not provide a complete list of all the organisations involved but aims to illustrate the breadth of organisations involved.

2 DSIT and the Met Office are LGDs for the whole of the UK. DESNZ is LGD for Great Britain. DfT is LGD for the UK regarding impacts on, and recovery of, aviation and maritime sectors and for England only regarding impacts on, and recovery of, rail and roads. The other LGDs mentioned in this figure are LGDs for England only. Where the LGD does not cover the whole UK, the administrations in each of the devolved nations are responsible for this phase of the risk lifecycle.

3 The Weather-Health Alert Service forewarns of periods of adverse temperatures, which may affect the health of the public. It is aimed at health and social care professionals and others with a role in reducing the harm extended periods of hot and cold weather can have on health. From 2023, it now gives an indication of the impacts likely to be observed because of the temperatures.

4 The UK Extreme Heat Escalation Protocol is a classified document that sets out the processes for escalation when an extreme heat event may require cross-government or ministerial-level coordination.

5 The Summer Resilience Network (renamed 'Winter Resilience Network' in the six colder months of the year) is a forum for severe weather preparedness, chaired by the COBR Unit. The forum holds seasonal preparedness meetings at the start of the summer and winter months and meets during emergencies to coordinate the response.

6 The Adverse Weather and Health Plan for 2023 to 2024 is produced by UKHSA and aims to support local and national organisations to prepare, build, and respond to adverse weather events to protect lives and promote health and wellbeing.

Source: National Audit Office review of government documents on extreme weather

Part Two

Identifying and understanding extreme weather events

2.1 This part assesses whether the UK government has a clear understanding of extreme weather events and the impacts that they can have. It covers:

- understanding of the risks, impacts and connections between risks;
- the use of scenarios in planning; and
- potential costs of extreme weather events and benefits of adaptive measures.

Understanding of risks

2.2 Government has a good understanding of most extreme weather risks and of many of their impacts, and this information is shared widely. The Met Office:

- produces short- and medium-term weather forecasts which help the public make informed decisions about day-to-day activities. For example, it can predict seasonal periods of storminess up to three months in advance.
- issues severe weather warnings, such as extreme heat warnings, to the public, businesses, emergency services and government, so that mitigating action can be undertaken to reduce potential impacts.
- provides the responders community with weather-related advice through a team of civil contingencies advisers. These advisers are distributed across the UK and advise local resilience forums, central government and devolved administrations; and
- produces a set of tools and data that shows how the UK climate may change in the future (UK Climate Projections).[11]

The Met Office is upgrading its supercomputing capability, with £1.2 billion (according to a 2021 business case) of investment from government, to improve its severe weather warnings, hazard and risk predictions.

11 Weather is a description of what the conditions are like in a particular place over hours or days. Climate is a description of the average weather conditions in a certain place over a much longer period, usually years or decades.

2.3 The Flood Forecasting Centre, run jointly by the Environment Agency and the Met Office, issues daily, five-day and monthly flood risk forecasts. The Environment Agency also issues drought projections. The Climate Change Committee (CCC) delivers climate change risk assessments, technical reports, home nation summaries and sector briefings on climate change, which cover extreme weather risks.

2.4 Government told us that understanding of the impacts of extreme weather risks is informed by learning from previous events in the UK. However, there is a lack of data on how high temperatures and heatwaves impact the UK because it has limited experience of this type of event. For example, some of the effects of longer periods of high temperatures on different sectors and infrastructure were unknown until the record-breaking temperatures experienced in July 2022. Government plans to undertake research to better understand the impacts of high temperatures and heatwaves. For example, in September 2023, the Cabinet Office convened a series of cross-government workshops on the impacts of extreme heat on critical national infrastructure (CNI) sectors. The findings will be considered by the Climate Resilience Steering Board.

2.5 Surface water flooding events, which are typically localised events, are not as predictable as droughts, heatwaves, storms or fluvial and coastal flood events. Currently, it is difficult to predict the location, timing and impact of surface water flooding due to uncertainties in the severity of the rainfall, how permeable the ground is, the drainage conditions, and because they normally happen very quickly. The Met Office issues weather warnings for rain and thunderstorms, both of which highlight when there is an increased likelihood of flooding of any type occurring, among a wider list of impacts. However, these weather warnings tend to focus on geographical areas of county scale or greater. The Environment Agency does not issue flood warnings for surface water flooding, as it does for other flooding events.

2.6 The Met Office plans to carry out further modelling of localised heavy rainfall and to continue to work alongside the Environment Agency and Flood Forecasting Centre to improve surface water flooding forecasting. The Met Office told us that its new supercomputer is expected to increase its computational capacity by six-fold by summer 2024 and might lead to a more precise identification of the areas that could be affected by surface water flooding and longer lead time for potential warnings. The Environment Agency is developing a new National Flood Risk Assessment, to be rolled out in late 2024, which it states will improve its assessment in areas such as surface water flood risk and the impacts of climate change. This assessment can be used by lead local flood authorities, which are responsible for developing and applying a strategy for local flood risk, and flood risk management authorities, which are responsible for managing flood risk (Figure 6).

Connection between risks

2.7 Government's understanding of how different risks can interact with each other is less well developed. This includes interconnections between risks, the amplifying impacts of risks on each other (compounding), and how risks in one system can have a knock-on effect in another system (cascading), particularly for risks that have not previously materialised. Recent examples of interconnecting and cascading risks which affected multiple systems include:

- in July 2022 London experienced temperatures reaching 40°C. This resulted in failures at two data centres used to host the legacy IT systems of Guy's and St Thomas' NHS Foundation Trust. These centres were designed to act as a back-up to each other if one failed. The cooling failures took down most of the Trust's clinical IT systems. Complete restoration took several weeks. The incident caused widespread disruption to patient care and clinical services, including to hospitals in the area to which patients were diverted; and
- Storm Arwen, in November 2021, knocked out power to many households. The households had no way of contacting emergency services because their phone lines were reliant on electricity to work. Mobile phones were redundant because some areas had no reception, or the storm damaged masts, or knocked out their power supply.

The Cabinet Office hosts a dedicated meeting (Summer Resilience Network and Winter Resilience Network) ahead of each seasonal risk period (Figure 6) to review risk and readiness. These meetings also consider the overall risk landscape and potential factors which may exacerbate or mitigate seasonal risks.

2.8 The increasingly linked nature of extreme weather risks means it is increasingly important that government identifies and limits cascading risks. Mapping these risks allows government to manage them as a system, where the system is only as strong as its weakest link. For example, risks to infrastructure networks from cascading failures is one of 61 risks identified by the third Climate Change Risk Assessment.[12] The Cabinet Office is working with departments to map CNI assets and the interdependencies between them to inform mitigation and planning. It aims to complete the first phase of this work by the end of 2023. Once completed, it should allow government to identify gaps and weaknesses in these systems and prioritise work to address them.

12 HM Government, *UK Climate Change Risk Assessment 2022*, January 2022.

The use of scenarios in planning

2.9 Government's planning is often based on reasonable worst-case scenarios, for example the scenarios set out in the National Security Risk Assessment (the Assessment). These scenarios are likely to need ongoing updating as the climate continues to change. For example, as part of the 2022 Assessment update process, the Met Office, in consultation with the UK Health Security Agency (UKHSA), updated the reasonable worst-case scenario for high temperatures and heatwaves because the old scenario was considered to have become a 'most likely' scenario.

2.10 Recent extreme weather events have sometimes exceeded planning scenarios, indicating the need for better long-term thinking that considers more scenarios. For instance:

- following the 2013 storms, planning scenarios were prepared to enable an improved storm response from the networks that provide customers with electricity. Storm Arwen in November 2021 exceeded the planning assumptions of those scenarios, such as expected customer call volumes, because its atypical northerly wind direction caused more damage than wind gusts coming from the prevailing south-west would have done. The Energy Emergencies Executive Committee Storm Arwen Review found that staff turnover and the move to remote exercising because of COVID-19 played a role in eroding readiness in some areas, especially around the less likely but higher impact risk of extended and widespread electricity disruption. It recommended that network operators and partners should review forecasting capabilities, alert levels and thresholds to ensure wind direction, speed and duration are taken into account to aid in effective severe weather planning. The review also recommended updates to reasonable worst-case scenarios for customer call volumes, against which response plans could be tested, and to planning assumptions for other sectors to plan against; and
- the Home Office is the lead government department (LGD) responsible for responding to wildfire. Its wildfire response plans focused on a single incident, but multiple concurrent wildfires took place in the summer of 2022. The Home Office has subsequently amended its response plan to account for multiple concurrent wildfires.

2.11 Water companies are required to set out a range of scenarios in their drought plans, which are produced every five years. The scenarios should show, among other things, the actions that water companies would take in different types of drought and the effects of a range of droughts, such as the worst drought on record.

2.12 Besides considering reasonable worst-case scenarios, it is good practice to consider multiple scenarios, including extreme scenarios that exceed the reasonable worst case. Government should carry out stress-testing based on these scenarios. Planners can use a matrix approach, with impact plotted against likelihood.[13] More extreme scenarios help planners to consider compounding and cascading impacts and identify points of failure. They can use this to determine where preventative action should be focused and develop response capabilities that can be activated in different scenarios. We found little evidence across our case studies that government had considered multiple scenarios.

2.13 HM Treasury has mandated central government departments and large arm's-length bodies to set out the resilience of their strategies against different climate-related scenarios in their annual reports, starting in 2025-26. The Task Force on Climate-Related Financial Disclosures' (TCFD) recommendations, on which the government's approach is based, include that organisations consider different climate-related scenarios.

Potential costs of extreme weather events and benefits of adaptive measures

2.14 Government has a reasonable understanding of the potential economic costs of future extreme weather events. Analysis for the CCC indicates at least eight climate change risks may each have a cost of more than £1 billion a year by 2050, assuming a 2°C increase in global temperatures above pre-industrial levels by 2100.[14] These include risks to businesses from flooding and risks to health and wellbeing from high temperatures. This analysis also highlights that there is an increasing evidence base of the economic benefits of many adaptation actions, which can help prevent these costs from being incurred. For example, the average benefit to cost ratio for:

- water efficiency measures is 11:1;
- heat alert and heatwave planning is 10.5:1;
- weather and climate services including early warning is 9:1; and
- flood preparedness and protection is 6:1.

13 For example: Royal Academy of Engineering, *Building resilience: Lessons from the Academy's review of the National Security Risk Assessment methodology*, April 2023.
14 Paul Watkiss Associates, *Monetary Valuation of Risks and Opportunities in CCRA3: Report to the Climate Change Committee as part of the UK Climate Change Risk Assessment 3*, May 2021.

Part Three

Preparing for and responding to extreme weather events

3.1 This part assesses whether government has the levers in place to develop resilience to extreme weather events including:

- developing plans and capabilities to manage the impacts of these events;
- using regulation and standards to improve resilience;
- funding and investment in activities that will help to manage these risks and develop resilience; and
- communication of risk to the public.

It also assesses the overall progress government has made in adapting to climate change risks such as extreme weather events.

Plans and capabilities to manage the impacts of risks

3.2 **Figure 7** on pages 40 to 42 sets out some of the main plans that government and others have in place to manage the impacts of droughts, high temperatures and heatwaves, storms and surface water flooding. For three of the four extreme weather risks we examined (all except drought), there was a lack of clarity on what outcome government is looking to achieve, such as target levels of preparedness, resilience, and an agreement on the level of tolerable risk, based on a well-informed risk appetite. Without these, it is impossible for government to identify the actions needed and evaluate progress. In the case of drought, water companies are required to plan to ensure resilience to a 1-in-200 year 'severe' drought and in their new plans in 2024, to a 1-in-500 year 'extreme' drought. Drought targets in other areas, such as the agricultural sector, are not in place. Although government told us that the Third National Adaptation Programme (NAP3) frames a high-level vision for a well-adapted UK, government's national adaptation plans to date have not clearly set out what goals government is looking to achieve (see paragraph 3.28). In comparison, goals exist for climate change mitigation and net zero, which have greater legislative and strategic weight. The Cabinet Office told us that it is embedding consideration of risk appetite in its ongoing work. It is developing options for different levels of investment that government may commit to specific response capabilities, depending on its risk appetite and tolerance.

Figure 7

Plans to manage the potential impacts of droughts, high temperatures and heatwaves, storms and surface water flooding in England

Government has taken a range of actions to develop contingency plans and plans to mitigate the risks

Organisation	Plans to manage potential impacts
Emergency response when there is an incident	
Category 1 responders[1]	Maintain plans for mitigating the effects of emergencies.
Local resilience forums	Publish community risk registers and prepare supporting emergency plans. These may include specific plans for extreme weather events. Follow escalation protocols to transfer the leadership of the response to serious incidents from local areas to lead government departments.
Met Office	Provide support and guidance to local resilience forums when risk assessing, planning for, responding to and recovering from extreme weather events.
Lead government departments (LGDs)	Lead and coordinate the central response to an emergency. Response encompasses the decisions and actions taken to deal with the immediate effects of an emergency. Follow escalation protocols to transfer the leadership of the response to very serious incidents from the LGD to the Cabinet Office.
Cabinet Office	Convenes the Cabinet Office Briefing Rooms (known as 'COBR'), a Cabinet Committee that deals with crises. Uses the National Situation Centre (established in 2021) to bring data (international, local, national and commercial), analysis and insight together, to improve government's ability to identify, monitor and manage risks and to inform decision-making in emergencies. Is drafting a severe storms response plan which will set out escalation processes and responsibilities and will incorporate lessons from Storms Arwen, Eunice and similar.

Figure 7 *continued*

Plans to manage the potential impacts of droughts, high temperatures and heatwaves, storms and surface water flooding in England

Organisation	Plans to manage potential impacts			
Preventative planning when an incident is on the horizon				
	Drought	**High temperatures and heatwaves**	**Storms**	**Surface water flooding**
Cabinet Office	Not within the Cabinet Office's remit. Overseen by the Department for Environment, Food & Rural Affairs (Defra) as LGD.	Convenes the Summer Resilience Network when necessary.[2] The UK Extreme Heat Escalation Protocol sets out escalation processes and responsibilities.	Convenes the Winter Resilience Network when necessary.[2]	Defra, in consultation with the Cabinet Office, convenes the National Flood Response Centre.[3]
Other organisations	Water companies produce a drought plan every five years, setting out how they will monitor water availability and the triggers for drought measures. Response activities include restrictions on water use (such as hosepipe bans), restrictions on supply, or applying to take more water from the environment to maintain supplies. The Environment Agency (EA) is responsible for monitoring, reporting, advising and acting to reduce the impact of a drought on the environment and water users. Its drought framework sets out roles and responsibilities, actions, monitoring and communication arrangements. Each EA area has a drought plan. The National Drought Group gives strategic direction to drought planning and response.	Activate sector-specific contingency plans, such as the rail sector's extreme weather response process and those for Fire and Rescue Services.	The extreme weather response process for the rail sector activates on forecast of extreme weather to support preparation, response and recovery from events. Energy network operators submit winter preparedness plans to the Department for Energy Security & Net Zero (DESNZ) annually. This was introduced following Storm Arwen.	Network Rail and National Highways have plans in place when heavy rain is forecast such as checking railway drainage, and roadside drainage respectively, and ensuring maintenance teams are on standby as appropriate. Multi-agency flood plans, produced by local resilience forums in collaboration with the EA, set out the roles and responsibilities of emergency responders and how agencies collaborate to respond to floods. Lead local flood authorities (unitary authorities or county councils) lead in managing local flood risks, including preparing and maintaining a strategy for local flood risk, carrying out works to manage local flood risks and playing a lead role in emergency planning and recovery after a flood event.

Figure 7 *continued*

Plans to manage the potential impacts of droughts, high temperatures and heatwaves, storms and surface water flooding in England

Organisation	Plans to manage potential impacts			
Longer-term resilience planning				
LGDs for critical national infrastructure (CNI)	In 2023, the Cabinet Office sent standardised questions to LGDs for CNI and will use the information to inform activities in LGDs and their CNI sectors to prepare for and manage risks.			
Road and rail infrastructure managers	Road and rail infrastructure managers produce reports under the Adaptation Reporting Power in the Climate Change Act (2008). These reports set out a detailed climate risk assessment for the organisation and actions planned to manage risks and adapt the organisation to climate change in the longer term.			
UK Health Security Agency (UKHSA)	Publishes its Adverse Weather and Health Plan which supports local and national organisations to prepare, build, and respond to adverse weather events to protect lives and promote health and wellbeing. The first plan was published in 2023. It brings together the UKHSA's previous heat and cold weather plans and guidance on flooding.			
	Drought	**High temperatures and heatwaves**	**Storms**	**Surface water flooding**
Other organisations	Water companies produce a water resource management plan every five years setting out how they will manage water resources in their region for the next 25 years, considering climate change. Their plans should ensure resilience to a 1-in-200 year 'severe' drought and, in 2024, to a 1-in-500 year 'extreme' drought. Five regional groups in England, comprising water companies and major water users, should produce final plans in autumn/winter 2023 identifying solutions for new supply in each region, including transfers and reservoirs. The Water for Food Group, a forum of stakeholders from the agricultural and horticultural sectors, is developing a template framework for agricultural water resource management and drought plans.	Network Rail's national and regional plans contain actions to prepare for warming scenarios of 3°C to 4°C. Network Rail has also launched an extreme weather risk task force, in response to the impacts of the summer 2022 heatwave on the rail network.	Ofgem requires electricity distribution network operators to include their climate resilience strategy in their published business plans.	Water and sewerage companies must produce drainage and wastewater management plans. These will become statutory in 2028.

Notes

1 Category 1 responders are laid out in the Civil Contingencies Act 2004. They include emergency services, local authorities, health bodies and the EA.

2 The Summer Resilience Network (renamed 'Winter Resilience Network' in the six colder months of the year) is a forum for severe weather preparedness, chaired by the COBR Unit. The forum holds seasonal preparedness meetings at the start of the summer and winter months and meets during emergencies to coordinate the response.

3 The National Flood Response Centre is convened when flooding is predicted with reasonable confidence and when flooding is likely to have significant impacts. Its purpose is to enable better cross-government working to maintain situational awareness, optimise response and support COBR.

Source: National Audit Office analysis of government documents

3.3 Government aims to gain assurance that response and resilience plans are fit for purpose by learning from past events, carrying out simulation exercises and through scrutinising plans. Government considers it impractical to validate the quality of all these plans; however, it often reviews its response to significant extreme weather events (**Figure 8** overleaf). For example, after all significant flooding events, investigations are carried out to identify learning points for central and local government to act upon. This learning feeds into the system the Department for Environment, Food & Rural Affairs (Defra) has in place for continuous improvement. An independent review, commissioned by Defra, has separately identified that local post-flood investigations are not carried out in a consistent way.[15] Defra told us that it has a project underway to provide new guidance on how to approach these investigations to improve consistency.

3.4 Exercises are carried out at national, departmental and local levels.

- Following a hiatus due to Brexit and the COVID-19 pandemic, the Cabinet Office has restarted the National Exercising Programme in 2022. The programme brings together key partners, including the devolved administrations, to embed lessons; stress test government's plans, structures and skills; and test government's ability to respond to risks that affect the whole of society. In 2023, a national exercise examined the UK's ability to cope with a national power outage.
- Relevant departments regularly carry out exercises. For example, between 2016 and 2023 Defra and the Environment Agency (EA) carried out five exercises on drought and flooding. After amending its wildfire response plan to account for concurrent wildfires, the Home Office tested the new plan in two exercises in 2023, one involving cross-government partners.
- Local resilience forums (LRFs) carry out risk-based programmes of exercises.

3.5 Our report on government's preparedness for the COVID-19 pandemic in 2021 highlighted that government did not always implement learning from previous exercises and recommended lessons should be communicated across government and embedded.[16] In response, the Cabinet Office Emergency Planning College now publishes the *UK Resilience Lessons Digest* twice a year. This summarises lessons from a wide range of relevant sources to share insights consistently across government and wider partners. The first issue in October 2022 shared lessons from Storm Arwen in 2021. The Department for Energy Security & Net Zero (DESNZ) and Ofgem reported that improvements were made to the energy sector's resilience following the Storm Arwen reviews. Government arrangements for recovering from emergencies recommend that lessons should be identified and shared for the benefit of those who might be involved in future emergencies. While we found evidence of government applying the learning from exercises, we saw less evidence of actions being implemented and embedded in prevention and preparedness following extreme weather events.

15 As set out in section 19 of the Flood and Water Management Act 2010.
16 Comptroller and Auditor General, *The government's preparedness for the COVID-19 pandemic: lessons for government on risk management*, Session 2021-22, HC 735, National Audit Office, November 2021.

Figure 8

Examples of learning from extreme weather events in the UK, 2021-2022

Government and others involved in managing risks from extreme weather events continue to learn from recent events

Event	Learning
Storm Arwen, November 2021	Several reviews were carried out. While many of the actions were directed at the energy sector, there was also learning of relevance to responding organisations and local stakeholders: ● Storms Arwen and Eunice exceeded planning assumptions, indicating a need to review the reasonable worst-case scenarios. Storm Arwen resulted in electricity disruption which went well beyond the expectations of both government and society. ● There were shortcomings in how energy providers identified and engaged with vulnerable customers, supported those affected and compensated them for loss of service. ● A principles-based, outcomes-focused resilience standard would allow operators to plan and invest, while setting government and public expectations of the service they fund.
Heatwave, July 2022	A Cabinet Office review of government's response made 14 recommendations, including: ● gaining a better understanding of the impact of prolonged extreme heat on sectors and infrastructure, such as 999 waiting times, Fire & Rescue Service capacity, and data centres; and ● the need for further sector-specific health guidance and training to familiarise government and local responders with response plans for high temperatures and heatwaves.

Source: National Audit Office review of government documents

3.6 We found limited oversight arrangements in place to ensure the quality or implementation of some contingency plans. For example:

- while LRFs produce emergency plans, central government has no direct oversight of these plans and does not assure them as government considers it impractical to test all plans. Government plans to strengthen accountability and assurance across these forums, both collectively and by building assessment of resilience activity into the inspection and audit regimes of individual responders; and
- previously, lead government departments (LGDs) prepared annual sector security and resilience plans that are classified. The Cabinet Office is updating the process and in 2023 sent standardised questions to LGDs for critical national infrastructure (CNI). The Cabinet Office told us that it has received returns and will use the information to inform activities in LGDs and their CNI sectors to prepare for and manage risks, and that the new process will inform key priorities for attention in 2024.

Standards and regulation

3.7 In May 2020, the National Infrastructure Commission recommended that government should publish a set of resilience standards for energy, water, digital, road and rail services, to be reviewed and updated every five years.[17] By 2030, government has committed to:

- reviewing existing regulatory regimes on resilience to ensure they are fit for purpose;
- introducing standards on resilience across the private sector, where these do not already exist; and
- building upon the resilience standards for CNI which already exist to create common but flexible standards across this infrastructure.

3.8 Between now and 2029 there will be new price controls for electricity, gas, and for water, a new control period for Network Rail and a new road period for National Highways. These price controls and control periods include determination of how much and where companies invest in infrastructure over that period. If resilience standards are not developed until 2030, all these regulatory cycles will be missed, pushing back the opportunity for investment to meet those standards until the 2030s. The National Infrastructure Commission has calculated that, if government does not set out clear service standards before 2030, around £400 billion of future investment in infrastructure may not be fully optimised for resilience.[18]

3.9 Some standards are already in place and others are being developed. For example:

- building regulations require that new homes are built to a standard of 125 litres per person per day water usage. Local authorities in water-stressed areas have discretion to ask for a more demanding standard of 110 litres per person per day;
- building regulations were updated in July 2022 to include an overheating standard for new builds;
- statutory guidance to building regulations promotes the use of flood resilient and resistant construction in flood prone areas;
- Network Rail, which manages most of Great Britain's rail infrastructure, has issued a range of standards on environment, drainage and weather management; and
- while the energy sector has standards on recovering power after extreme weather, resilience against floods and incident recovery, most of these standards do not set a specific level for resilience against climate change. Energy network operators are developing an outcomes-focused physical network resilience standard expected to be implemented by 2028.

17 National Infrastructure Commission, *Anticipate, React, Recover: Resilient infrastructure systems*, May 2020. The National Infrastructure Commission is an executive agency of HM Treasury, providing government with impartial, expert advice on major long-term infrastructure challenges.

18 National Infrastructure Commission, *The Second National Infrastructure Assessment*, October 2023.

3.10 Most infrastructure regulators do not have specific duties regarding climate resilience. Ofwat is the exception, and the Climate Change Committee (CCC) has noted that it has had a more positive impact on infrastructure climate change adaptation than other regulators due to its explicit adaptation requirement.

3.11 The Cabinet Office published a set of national resilience standards for LRFs in 2020. These standards provide a consistent way for forums and their constituent local responder organisations to self-assess their capabilities and level of readiness, and to guide continuous improvement against mandatory requirements, good and leading practice. However, the standards have no formal status and their use is voluntary. As part of the wider strengthening of the roles and responsibilities of forums, government will consider putting the standards that apply to responder organisations in England onto a statutory footing, and requiring responders to publicly state how they are meeting their obligations.

Funding and investment

3.12 Government cannot provide an estimate of how much it spends to manage the risks for droughts, high temperatures and heatwaves, surface water flooding and storms, because action is taken by a wide range of government departments and agencies, and no one collects this information. **Figure 9** provides some examples of funding and investment. Government cannot identify how much is spent on resilience activity as there is no common definition of what constitutes resilience activity.

3.13 Government has committed to developing a coordinated approach to investment in resilience by 2030, noting that to make strategic investment decisions, it needs to understand how current capabilities match up with risks and concentrate investment where gaps are identified. As a first step, it aims to agree on a working definition of resilience activities and capabilities, and using that, will map current government resilience capabilities. It also plans to start measuring and tracking departmental investment in resilience across national risks, meaning risk-owning departments will be able to track investments. We found little evidence of how risk assessment feeds into government funding decisions across our four case studies. Defra told us that, across all sources of flood risk, the level of government investment depends on the number of feasible projects available and their benefits as well as where flood risk is greatest.[19]

19 Comptroller and Auditor General, *Managing flood risk*, Session 2019–2021, HC 962, National Audit Office, November 2020.

Figure 9

Examples of funding and investment by government and regulated sectors to manage the risk of extreme weather events in England, 2020–2032

Information on funding and investment is available for weather-related risks and resilience, drought and surface water flooding, but not for heatwaves and storms

<table>
<tr><th>Drought</th><th>High temperatures and heatwaves</th><th>Storms</th><th>Surface water flooding</th></tr>
<tr><td colspan="4">The Met Office's responsibilities around weather-related risks are managed as part of the Public Weather Service that it provides.
Between 2022 and 2025, the Met Office will receive £425 million in funding for this service, mostly from the Department for Science, Innovation & Technology.

Between 2022 and 2032, government is investing £1.2 billion (according to a 2021 business case) in the Met Office's next supercomputer to further improve weather forecasts, severe weather warnings, hazard and risk predictions.

Network Rail's Strategic Business Plan includes investment of £1 billion on weather resilience activities between 2024 and 2029.</td></tr>
<tr><td>Ofwat's 2019 price review set a five-year (2020–2025) price and service package for water companies in England and Wales of £51 billion. This includes:
• £13 billion for new infrastructure to increase resilience;
• £643 million to increase the resilience of water and wastewater infrastructure against potential failures; and
• £469 million for drought resilience to develop new water resources and enable transfer of water across the country.

Ofwat has proposed a new allocation of £100 million for demand reduction in the next performance cycle, which will start in 2024.

The Environment Agency (EA) spent at least £9 million on drought monitoring in 2022.</td><td>No information provided</td><td>No information provided</td><td>Government committed to spend £5.2 billion on flood protection between 2021 and 2027. Of this, the EA currently estimates an allocation of £661 million to surface water flooding projects.

Ofwat's 2019 Price Review includes water companies investing over £1 billion to reduce the impact of flooding on communities across England and Wales.

In April 2022, Flood Re announced the introduction of 'Build Back Better', a scheme which allows participating insurers to reimburse homeowners up to £10,000 for the cost of installing property-level protections, over and above the cost of flood repairs.[1]</td></tr>
</table>

Note

1 Flood Re is a public-private reinsurance scheme to make flood insurance cover more widely available and affordable.

Source: National Audit Office review of government documents

3.14 Public and private sector investment is critical in developing national resilience to extreme weather events and to the impacts of climate change. The Infrastructure and Projects Authority estimates that total infrastructure investment over the next 10 years, including private investment, will be nearly £650 billion.[20] Only 9% of the funding secured to date for flood defence projects, where local communities raise funds from both the private and public sector through partnership funding, has been secured directly from the private sector, even though businesses are major beneficiaries from flooding defence projects.[21] In 2023 government launched the Water Management Grant Round 2 to encourage arable or horticultural business to invest in water sustainability to improve productivity. The grant allows up to 40% costs up to a maximum of £500,000 with private investment making up the remaining 60%. Rural Payments Agency estimates that Water Management Grant Round 1 has paid £1.5 million to date. The CCC has highlighted that barriers to investment remain, including information barriers such as general awareness and understanding of adaptation, including by investors.[22]

3.15 The 2023 Green Finance Strategy highlights government's intention to take action to prepare the UK for the physical impacts of the changing climate, to align financial flows with a climate-resilient economy, and to increase investment in adaptation.[23] The strategy's commitments on adaptation are substantially weaker than those on net zero and on nature: for adaptation there is a lack of concrete goals and actions, milestones and plans to address the key barriers to adaptation; and there is a lack of scale and urgency in action compared with the magnitude and proximity of the risks. Government has committed to set out deliverables and an action plan for climate adaptation finance by the end of 2024.

3.16 Australia and New Zealand are collaborating on the Investor Group on Climate Change. The group aims to stimulate investment in climate resilience and protect against the physical risks of climate change. Its strategy sets out a business case for why physical climate risks are financial risks and supports a 'whole of society' approach, based on the understanding that all stakeholders have a role to play to ensure the costs of climate change do not fall on those most vulnerable and that governments cannot bear the cost alone (see Appendix Two).

20 Infrastructure and Projects Authority, *Analysis of the National Infrastructure and Construction Pipeline 2021*, August 2021.
21 Comptroller and Auditor General, *Resilience to flooding*, Session 2023-24, HC 189, National Audit Office, November 2023.
22 Climate Change Committee, *Investment in a well-adapted UK*, January 2023.
23 HM Government, *Mobilising Green Investment: 2023 Green Finance Strategy*, March 2023.

Public weather alerts and warnings

3.17 Individuals can be better prepared if they are aware of and informed about the risks that are most likely to affect them and the actions they can take. The Met Office undertakes a range of activities, including issuing severe weather warnings, to inform the public (see paragraph 2.2). People can sign up for flood warnings from the EA which include fluvial, coastal and groundwater flooding, but not surface water floods, and for alerts from the Met Office for weather warnings or to receive notifications via the Met Office app. In April 2023, government tested a new system of emergency alerts, to get urgent messages quickly to mobile phones when there is a risk to life and provide clear instructions about how best to respond. The alert service will initially be used as part of government's flood warning response capabilities. It may be used for other scenarios, such as public health emergencies and fires.

3.18 The Met Office's WeatherReady campaign provides seasonal advice from selected organisations to help the public prepare for and respond to the weather, to stay safe and protect themselves, their homes and businesses. The Met Office also monitors trust and reach, and uses regular surveys and research to review communication methods. This is because some demographics are harder to reach, and the ways the public consumes weather forecasts is changing. For example:

- of the 2062 members of the public surveyed in February 2023, 80% said they trusted the Met Office; and
- for the July 2022 heatwave, of those surveyed who had seen or heard something about the high temperatures, 90% found the communication was fairly or very useful and 58% acted in response.

3.19 Surveys commissioned by the National Infrastructure Commission show that public awareness of the risk of surface water flooding is low, and a review commissioned by government in 2020 showed the public does not know who to report surface water flooding incidents to when they happen.

Communication with the public about risks and preparedness

3.20 More information is shared with the public in the latest National Risk Register, updated in 2023, than previous versions (see paragraph 1.10). LRFs produce community risk registers that set out the greatest risks to each local area, what is being done to manage them and where the public can get help or advice. Of 42 community risk registers in England and Wales, 43% may give the public partly outdated information as they have not been updated since the start of the COVID-19 pandemic. Coverage of extreme weather events of community risk registers is variable, with detailed information about surface water floods in 50%, droughts in 38%, high temperatures and heatwaves in 43% and storms in 42%.

3.21 Research commissioned by the National Infrastructure Commission into public perceptions of the current state of infrastructure provision in the UK highlighted public concerns about the ability of infrastructure to withstand more extreme weather in the future. Flood management showed the lowest levels of confidence in meeting needs in the next 30 years. Respondents living in villages and hamlets were significantly less likely to be confident compared with those in towns and cities. Half of respondents indicated willingness to pay a levy each year for flood protection.

3.22 To inform its communication of risk to the public, government plans to conduct an annual survey to understand how aware the public is of the risks the UK faces and how prepared people are for emergencies. It also plans to develop a measurement of socio-economic resilience, including how risks affect communities and vulnerable groups. People experience different levels of exposure to extreme weather, and factors such as location, income and health affect people's ability to cope with and respond to these events. Better understanding of vulnerability to the impacts of extreme weather could be used to target adaptation measures and emergency response.

3.23 Work undertaken by the Met Office on communicating to vulnerable audiences highlighted the need to simplify forecasts and warnings, provide preparedness advice in collaboration with expert partners and create a longer-term accessible communications strategy. Government plans to strengthen the requirements around the production of community risk registers so that responders consider community demographics, particularly vulnerable groups. It also plans to engage with groups who are disproportionately affected by risks to better understand what prevents them from preparing and to produce materials for use in risk planning and response.

3.24 New Zealand's National Emergencies Management Agency runs a national communications campaign on how to prepare for emergencies. The 'Get Ready' campaign encourages households, workplaces, schools and communities to be ready. It provides information on what to do before, during and after natural hazard events, including floods and storms. Appendix Two sets out other international examples.

Overall progress in adapting to climate change

3.25 The National Adaptation Programme has been government's main legislative accountability framework for understanding and responding to climate risks (including extreme weather) since 2008, but the CCC has repeatedly highlighted that government has displayed a lack of urgency on adaptation and needs to pick up the pace.[24] Its 2023 assessment found very limited evidence of the implementation of adaptation at the pace and scale needed to fully prepare for climate risks facing the UK across cities, communities, infrastructure, economy and ecosystems.

3.26 Key issues include:

- drought resilience requires reducing demand, reducing leakages and increasing supply. There has been a lack of progress in reducing demand, limited progress in reducing leakages and no new reservoirs have been built in the last 30 years (**Figure 10** overleaf);
- the National Infrastructure Commission and the CCC have highlighted that infrastructure, such as roads, rail, power, and data centres, is not designed to withstand extreme weather events, particularly high temperatures and heatwaves;
- there is no policy to address overheating in existing homes and buildings. In addition, plans for new developments do not thoroughly regulate or track adaptation for future climate resilience and there are no clear mechanisms to monitor and mitigate the effects of urban heat islands; and
- most policy for emergency response within communities is focused on flooding, but often does not extend to other climate hazards.

24 The CCC is an independent, statutory body established under the Climate Change Act 2008. Its role is to advise the UK and devolved governments on emissions targets and to report to Parliament on progress made in reducing greenhouse gas emissions and preparing for and adapting to the impacts of climate change.

Figure 10

Performance against targets for improving drought resilience in England

There has been a lack of progress in reducing demand, limited progress in reducing leakages and no new reservoirs have been built in the last 30 years

Area	Target	Performance
Reducing usage	Reduce the use of public water supply in England from 2019-20 levels of 140 litres per person per day, by 20% by 2037-38 and to 110 litres per person per day by 2050. Reduce non-household water use by 15% by 2050.	Over the past 10 years there has been no significant reduction in consumption. It is currently at 141 litres per person per day.
Reducing leakages	Water companies have committed to reducing leakage by 16% by 2025 and 50% by 2050. Government has set interim targets for water companies to reduce leakage by 20% by March 2027 and 30% by March 2032.	By 2021-22, water companies had reduced leakage by 11% from 2017-18 levels. Significant progress is still needed to meet the 2025 and 2050 targets.
Increasing supply	While there are no statutory targets, there are statutory planning requirements for increasing supply.	No new reservoirs have been built in the UK in the last 30 years, but new schemes are underway such as Havant Thicket reservoir. Infrastructure improvements in the past 10 years include expansion of a reservoir near Colchester and new pipelines to supply water in West Cumbria.

Source: National Audit Office analysis of government documents

3.27 The Third National Adaptation Programme (NAP3), published in July 2023, outlines several new activities. These include:

- the Cabinet Office and Defra, working with HM Treasury, to establish a new, senior officials' Climate Resilience Board (CRB) to oversee strategic, cross-cutting climate adaptation and resilience issues and drive further government action to increase UK resilience to climate change. The CRB's first meeting took place in October 2023;
- the Department for Business & Trade will survey business readiness for climate impacts and work with other departments to provide information and support to businesses on adapting to higher temperatures, water scarcity, storms and flooding;
- Defra will incorporate climate change adaptation into the design of Environmental Land Management schemes to promote resilient and sustainable land management and farming practices; and
- government departments undertaking work to better understand heat impacts in various sectors. For example, the Department for Levelling Up Housing & Communities, Department for Energy Security & Net Zero, Department of Health & Social Care and the UK Health Security Agency (UKHSA) undertaking research to improve identification of buildings that are most vulnerable to extreme heat, and the Department for Education producing an annual overheating assessment.

The Chair of the CCC Adaptation Committee stated that NAP3 "is a progress on previous plans". However, the Committee was disappointed that government did not "go further to build the UK's resilience to climate change".

Appendix One

Our evidence base

1 We reached our independent conclusions on the UK preparedness for extreme weather events following analysis of evidence collected primarily between January and September 2023.

Case studies

2 Our report sets out four case studies of extreme weather events. We selected a qualitative sample of case studies from the national risks included in the National Risk Register and National Security Risk Assessment: droughts, high temperatures and heatwaves, surface water flooding, and storms. We selected these case studies to cover risks that differ in their nature, kinds of impacts, the impact ratings assigned by government, and that involve more than one lead government organisation. We used the case studies to set out how government anticipates, assesses, prevents, mitigates, responds to, and recovers from specific types of extreme weather events.

3 Appendix Two sets out three case studies on how other countries manage extreme weather risks. To identify these case studies, we reviewed publicly available information on actions undertaken outside of the UK to prevent, prepare for and respond to extreme weather events. We also submitted an information request to the Supreme Audit Institutions of 21 countries to gather information on the work they had undertaken on resilience and on arrangements for national resilience in their countries. We selected a qualitative sample of three countries (Australia, Germany and New Zealand) because of their geographies and economies, approaches to 'whole of society' resilience, accountability and public information sharing.

Interviews

4 We had regular unstructured meetings with officials from the Cabinet Office, the Department for Environment, Food & Rural Affairs and the Met Office throughout the study, in which we discussed the topic and possible sources of evidence. We carried out five semi-structured interviews with the Cabinet Office on roles and responsibilities of the Resilience Directorate and the Cabinet Office Briefing Rooms (COBR) Unit, the Emergency Planning College, national exercising and extreme weather and climate change adaptation.

5 We carried out the semi-structured interviews set out in **Figure 11** with government representatives. All interviews were held remotely. We held two interviews with the Environment Agency and one interview with each of the other bodies mentioned in the figure.

Figure 11

National Audit Office interviews with government bodies, including executive agencies, on extreme weather resilience, January–September 2023

We interviewed a range of government bodies, including executive agencies, as part of our work on government resilience to extreme weather

Interviewee	Topic
Central government	
Environment Agency	Its role, actions and plans for climate change adaptation and for flood and drought resilience.
Department for Levelling Up, Housing & Communities	Its support of local resilience forums.
Department for Science, Innovation & Technology	Its oversight of the Met Office.
HM Treasury	Government funding for resilience.
Home Office	Its role, actions and plans as the lead government department for wildfires in England.
Emergency Planning College	Its work to strengthen national resilience and its perspective on national preparedness for emergency.
UK Health Security Agency	Its work to mitigate the public health impacts of extreme weather.
Ofgem	Climate resilience roles of the regulators for critical national infrastructure.
Ofcom	
Office of Road and Rail	
Ofwat	
Local government	
County Durham and Darlington Local Resilience Forum	Extreme weather resilience at the local level.
Local Government Association	
Humber Emergency Planning Service	
Devolved administrations	
Scotland	Roles, actions and plans to prevent, prepare for and respond to extreme weather events in Scotland and Wales, differences and similarities with England, and coordination with central government.
Wales	

Source: National Audit Office

6 We held one remote, semi-structured interview with each of the following experts on climate change, emergency preparedness and extreme weather to discuss their perspective on extreme weather resilience and gather feedback on our early thinking: Nigel Arnell (University of Reading); Richard Dawson (Newcastle University and the Climate Change Committee); David Denyer, Jim Harris and Simon Jude (Cranfield University); Hayley Fowler (Newcastle University); Bruce Mann (National Preparedness Commission); Margaret Read (National Infrastructure Commission); Tom Roberts (University of Surrey); Duncan Shaw (University of Manchester); Richard Smith-Bingham (Marsh McLennan) and Swenja Surminski (Marsh McLennan and London School of Economics and Political Science); and representatives of Zurich Insurance.

7 We also held three semi-structured interviews with the Climate Change Committee (one in-person and two remote) to discuss its role supporting government preparedness for extreme weather, its views on the UK's resilience to extreme weather and key findings from its recent reports, and a remote, unstructured interview with the European Court of Auditors to discuss EU-wide work on extreme weather resilience.

Engagement with experts

8 In addition to the interviews with experts mentioned above, we held an in-person roundtable discussion with an expert panel to gather feedback on our emerging findings. Panel members were representatives of the Climate Change Committee, the Government Office for Science, the National Infrastructure Commission, the National Preparedness Commission, Newcastle University, PwC and Zurich Insurance.

9 Internally, as part of our standard quality assurance and internal consultation procedures, we engaged with experts in risk management and climate change and we liaised regularly with the team carrying out a study on resilience to flooding to seek guidance and test our early thinking.

Document review

10 Before our study was approved, we did a thorough search using common tools such as Google, as well as in-house resources, to find publicly available documents relating to national resilience, climate change impacts and adaptation, with a focus on central and local government roles, actions and plans. We also reviewed relevant reports from the National Audit Office's back-catalogue. This initial document review informed our study questions.

11 After the study was approved, we formally requested documents from the Cabinet Office, the Department for Environment, Food & Rural Affairs and the Met Office relating to our study questions and carried out a further search for publicly available central and local government documents and websites, academic literature, and reports from independent bodies such as the Climate Change Committee and National Infrastructure Commission. We reviewed each document against our audit questions.

12 Using a government website and through search using common tools such as Google, we gathered data on the Community Risk Registers published online by the local resilience forums of England and Wales, which we analysed based on when they were last updated and inclusion of flood, drought, storm and high temperatures and heatwave risks.

Survey and focus group

13 The resilience to flooding study team carried out a survey in which we included a question about surface water flooding. The purpose of the survey was to understand issues affecting local authorities in addressing flood risk within their local areas. The target audience was flood risk managers, or comparable postholders, and recruitment was undertaken with the assistance of the Association of Directors of Environment, Economy, Planning and Transport (ADEPT). The survey was designed to capture a range of views on flood risk and inform the study team of possible areas of interest, although it did not aim to be statistically representative. The survey was carried out online in July 2023 and received responses from 50 out of the 152 local authorities with a role in managing flooding and coastal erosion in England (a response rate of 33%). A focus group was conducted with six survey respondents to further explore the points raised in the survey.

Site visits

14 We visited:

- the Cabinet Office's National Situation Centre to inform our thinking on how data are used when a serious extreme weather event occurs; and
- the Met Office's head office in Exeter to conduct interviews with staff and see weather forecasting and civil contingencies work in action.

Attendance at events

15 We attended the following events to inform our thinking on extreme weather resilience:

- a keynote speech on climate change and resilience by Sir James Bevan, former Chief Executive of the Environment Agency;
- three teach-ins delivered by the Environment Agency, two on floods and one on drought;
- a teach-in delivered by the Cabinet Office on the National Risk Register and National Security Risk Assessment;
- a symposium on climate change risk, organised by the National Audit Office, with participants from government departments and arm's-length bodies, the Climate Change Committee, KPMG and the National Infrastructure Commission;
- a conference at Cranfield University on *A resilient future: Building organisational and societal resilience* with academic speakers covering a range of resilience-related disciplines; and
- a Whitehall Industry Group symposium on Implementing UK Government Resilience Framework with a keynote speech from Mary Jones, Resilience Director/Head of Resilience at the Cabinet Office.

Appendix Two

International examples of managing extreme weather risks

1 **Figure 12** overleaf sets out examples of managing extreme weather risks from New Zealand, Australia and Germany.

Figure 12

International examples of managing extreme weather risks from New Zealand, Australia and Germany

Nations take different approaches to oversight, involving the whole of society and investment

	New Zealand	Australia	Germany
Overseen by	National Emergency Management Agency	Australian Government National Emergency Management Agency	Federal Office of Civil Protection and Disaster Assistance
Risks include	Floods, storms, landslides, earthquakes, tsunamis and volcanic activity.	Floods, bushfires, cyclones and tsunamis.	Floods, fires, storms, heat, droughts, snow and avalanches.
Approach	It has a *Get ready* public information website. Features how to prepare by household, school, community, workplace and marae (a communal or sacred place that serves religious and social purposes in Polynesian societies). Preparedness includes talking about impacts, working out supplies, planning, staying informed and the safety of buildings. There is information for teachers on teaching about emergencies in primary schools. A National Disaster Resilience Strategy considers people disproportionately affected by disaster, including children, young people and people with disabilities.	It has one end-to-end government agency responsible for response, recovery and resilience. It has a strategy, framework and plan to reduce disaster risk, and statements of responsibilities of government, business, third sector and individuals. The Australian Institute for Disaster Resilience acts on behalf of government to share disaster resilience education, knowledge and information with the public. This includes the 2021 handbook *Disaster Resilience Education for Young People*.	The German federal states are responsible for implementing protective measures for extreme weather events. The federal government may support them where incidents affecting several states arise. Germany has a *How to prepare for disasters* public information website. Personal preparedness help includes emergency packs, hygiene, keeping up to date, medicines, important documents, stockpiling and the safety of buildings.
Climate change preparedness and adaptation	National Adaptation Plan 2022–2028.	National Climate Resilience and Adaptation Strategy 2021–2025.	Federal states and the government have Climate Preparedness Services in addition to the government's Climate Action Programme 2030.
Investment	Australia and New Zealand are collaborating on the Investor Group on Climate Change. The group's strategy aims to stimulate investment in climate resilience and protect against the physical risks of climate change. The strategy sets out a clear business case for the financial impact of physical climate risks and supports a 'whole of society' approach, where all stakeholders have a role to play to ensure the costs of climate change do not fall on those most vulnerable and that governments cannot bear the cost alone.		German federal government funding is via the National Flood Protection Programme and the Promotion of Measures for Adaptation to Impacts of Climate Change.

Source: National Audit Office review of publicly available New Zealand, Australian and German government documents

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