

UK Climate Change Risk Assessment Evidence Report 2021

Method document, Version 0.3

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1. Purpose of the method document

This document sets out the detailed approach for the UK Climate Change Risk Assessment Evidence Report (2021) that is being produced by the Adaptation Sub-Committee of the Committee on Climate Change, for the UK Government.

This document has three purposes:

1. To enable early agreement from the various governance groups for the CCRA to the approach to be taken in compiling the 2021 Evidence Report.
2. To provide a consistent method for all chapter authors to follow in undertaking the assessment.
3. To provide a record for those who want to understand or critique the approach to, and rationale for, this assessment.

2. Context

The UK Government is required under the 2008 Climate Change Act to publish a UK-wide climate change risk assessment every five years.

The [first assessment](#) was published in 2012 and the [second assessment](#) in 2017. The Adaptation Sub-Committee of the Committee on Climate Change (ASC) is required under the 2008 Climate Change Act to provide advice to the Government on the CCRA. For the first CCRA, the ASC reviewed the method and outputs of the Evidence Report funded by Defra and produced by a consortium of organisations led by HR Wallingford. For the second CCRA, the ASC produced the [Evidence Report](#). For the third assessment, Defra has again asked the ASC to prepare an independent Evidence Report by July 2021.

The UK Government will lay before Parliament a CCRA3 Government Report with its summary of the CCRA by January 2022. Both the ASC and Government reports will then feed in to the development of the next UK National Adaptation Programme, as well as the national adaptation programmes of the devolved administrations.

The CCRA3 Evidence Report will cover England, Northern Ireland, Scotland and Wales. It will not cover the Crown Dependencies or Overseas Territories.

NOTE – references to ‘CCRA1’, ‘CCRA2’ and ‘CCRA3’ throughout the rest of this document refer only to the CCRA Evidence Report, not the Government report. Separate preparations for that report are being made by Defra. Where we discuss the Government Report, it is referred to as such.

Following reviews of CCRA2, the Government has requested that the CCRA3 Evidence Report do the following:

- Inform the adaptation plans of the UK Government and the devolved administrations.
- Make the outputs and key messages more accessible for these audiences than CCRA2 (e.g. greater use of infographics, guidance on entry points to the outputs, shorter, crisper and less technical summary reports).
- Use a more systems-based approach than CCRA2 to take better account of interdependencies and interactions (e.g. through making assessments for appropriate place-based systems such as coasts and cities).

- Take account of new evidence on climate projections (namely UKCP18, which is due for publication in November 2018)
- Involve a more systematic review of risks than took place under CCRA2.
- Use the urgency framework developed for CCRA2, refining it to identify a smaller number of specific priorities for the next five year period.
- Not make decisions or recommendations about what risk appetite should be or on how to adapt, since those are policy or operational decisions. It may however, where appropriate, and for consistency with CCRA2 include consideration of some adaptation scenarios that go beyond planned adaptation.

CCRA3 has a higher budget than CCRA2 but lower than CCRA1 and this has influenced the method that can be applied.

The budget for the CCRA3 Evidence Report is about £1.8 million (compared to approximately £3.2 million for CCRA1 and £650K for CCRA2). As a result, there will be more investment in supporting research projects than for CCRA2, but the exercise to compile the Evidence Report will still primarily be a synthesis of the available research. This means that some of the same methodological issues that were present for CCRA2 will also be relevant for CCRA3. The evidence taken from the literature to inform the assessment will come pre-packaged with different assumptions on the degree of projected climate change, socio-economic change, adaptation and so forth. Different studies will also use different geographical regional breakdowns and baseline periods. This means that consistently scoring or summarising the most important risks to the UK is challenging. In particular, while it is expected that the analysis may include a range of climate and socioeconomic assumptions, the UK Government has asked that the size of the risks and opportunities be summarised for a 2°C and a 4°C world.

The approach outlined in this document is based around applying an 'urgency framework' to summarise the risks and opportunities, and that allows many of the differences in underlying assumptions of different sources of evidence to be dealt with to some extent.

3. Primary and secondary goals for the CCRA3 Evidence Report

The method for the Evidence Report has been developed to fulfil the following primary, and where possible secondary, goals, as set out in the Government customer requirement document.

The **primary goal** of the CCRA3 Evidence Report is to provide an assessment of the risks and opportunities for the UK from climate change impacts, and to identify the priority risks and opportunities to address over the next five year period, to enable the UK government and devolved administrations to set out objectives, proposals and policies for adapting to climate change.

In addition, unless it conflicts with the primary goal, the CCRA3 evidence report should also seek to fulfil the following **secondary goals**:

- a) Inform others making investment and policy decisions where climate is a significant factor;
- b) Show progression since CCRA1 and CCRA2 on how our understanding of the level of current and future risk has changed since 2012; and
- c) Act as a stepping stone to CCRA4 in terms of the approach and framing.

4. Evidence Report structure and products

Table 1 sets out the various products that will make up the CCRA3 Evidence Report:

Table 1: Evidence Report products			
Product	Number/scope	Purpose	Authorship
Research project reports	<ol style="list-style-type: none"> 1. Water projections 2. Flooding projections 3. Behaviour change 4. Natural environment thresholds 5. Interacting risks 6. Socioeconomic dimensions 	To provide supporting evidence to inform the Evidence Report technical chapters, summary documents and synthesis report	Written by contractors to the ASC
Evidence Report Technical chapters	<ol style="list-style-type: none"> 1. Introduction 2. Approach 3. Natural environment 4. Infrastructure 5. People and the built environment 6. Business 7. International risks 	<p>To provide the detailed analysis that underpins the assessment of risks/opportunities and resulting urgency scores.</p> <p>Within each chapter, the analysis will be set out by risk as per CCRA2, but there will be a stronger focus on how the scale of risk differs around the country.</p> <p>Each chapter must contain a section on cross-cutting issues.</p>	Written by contractors to the ASC
Summary briefings (spatial element)	<ol style="list-style-type: none"> 1. England 2. Scotland 3. Wales 4. Northern Ireland 5. Urban 6. Coastal 7. Marine 7. Uplands 8. Lowland rural landscapes 	Based on the content in the technical chapters, to summarise the most urgent risks and opportunities from the technical chapters	Written by contractors to the ASC
Synthesis Report	One report to cover a summary of the whole of the Evidence Report	To provide a summary of the main conclusions of the Evidence Report, focusing on the results of the urgency scoring and adaptation priorities for the next five years	Written by the ASC

Research projects

Following a compilation of over 200 evidence gaps from CCRA2 and a stakeholder engagement period in 2016 – 2018, the ASC has commissioned six research projects, using funding provided by Defra, the devolved administrations and research councils (NERC, ESRC and EPSRC):

1. Updated projections of future water availability for the UK
2. Updated projections of future flood risk for the UK
3. How behaviour change can influence climate change risks and opportunities
4. Climate driven threshold effects in the natural environment
5. Interacting risks
6. A consistent set of socioeconomic dimensions for the CCRA3 Evidence Report research projects

Each of the technical chapters will utilise the results of these projects in relevant parts of the analysis. These research projects will be independently peer-reviewed and published between autumn 2019 and March 2020.

Evidence Report technical chapters

The choice of the technical chapters for CCRA3 is the same as for CCRA2 as this allows the project team to structure the analysis by risk, and is where we think the greatest number of linkages lie between different risks and opportunities.

We will have a single chapter up front summarising the report's approach and context (chapter 2). Rather than including a dedicated chapter on cross-cutting issues as was the case for CCRA2, we expect the cross-cutting nature of the risks to be highlighted in a dedicated section in each chapter, partly using the results of the 'interacting risks' research project. The proposed chapters are as follows. The list in brackets outlines how the chapters were structured for CCRA2 and the same structure may or may not be followed for CCRA3:

Chapter 1- **Introduction** (context and audience for CCRA3; aims and approach, products and supporting material; definition of risk; observations and projections of UK climate).

Chapter 2- **Approach and context** (approach; differences in approach with CCRA2 and CCRA1; understanding present-day and future vulnerability; prioritising risks according to urgency; cross cutting issues and guidance on using CCRA3).

Chapter 3- **Natural environment and natural assets** (terrestrial ecosystems; soils and land use; freshwater ecosystems and water services; coastal ecosystems and buffering of hazards; marine ecosystems and cross-cutting issues).

Chapter 4- **Infrastructure** (cross-cutting climate risks to infrastructure; flood and coastal erosion risk management; water supply; digital communications (ICT); transport; energy; and solid waste).

Chapter 5- **People and the built environment** (communities and settlements; buildings; health and social care system; population health and health protection; and opportunities and challenges).

Chapter 6- **Business and industry** (site locations; access to capital; workers and labour productivity; supply chains and distribution networks; products and services; and the importance of adaptive capacity).

Chapter 7- **International dimensions of risk** (food systems; migration and displacement risks; and geopolitical dimensions of climate change).

Summary Briefings

The summary briefings will pull out the most relevant information on the most urgent risks and opportunities from the technical chapters and present it for different audiences. There will be a

limit on how many summary briefings can be produced, but there is some flexibility here to allow briefings to be produced for different audiences in addition to producing the spatial briefings. The summary briefings are likely to be where the spatial element of the CCRA comes out most strongly.

Synthesis Report

The ASC will also produce a synthesis of the Evidence Report's key findings at the UK level, summarising the most urgent risks and opportunities for the UK Government and devolved administrations between 2022 and 2027.

5. Urgency scoring method

The Government Customer Requirement Document for CCRA3 sets out the need for the Evidence Report to focus on areas where the need for adaptation is likely to be most 'urgent' between 2022 and 2027. Urgency is defined here as 'a measure of the degree to which it is felt that action is needed to reduce a risk or realise an opportunity from climate change'. CCRA3 will use broadly the same urgency scoring method as CCRA2, set out below in **Figure 1**.

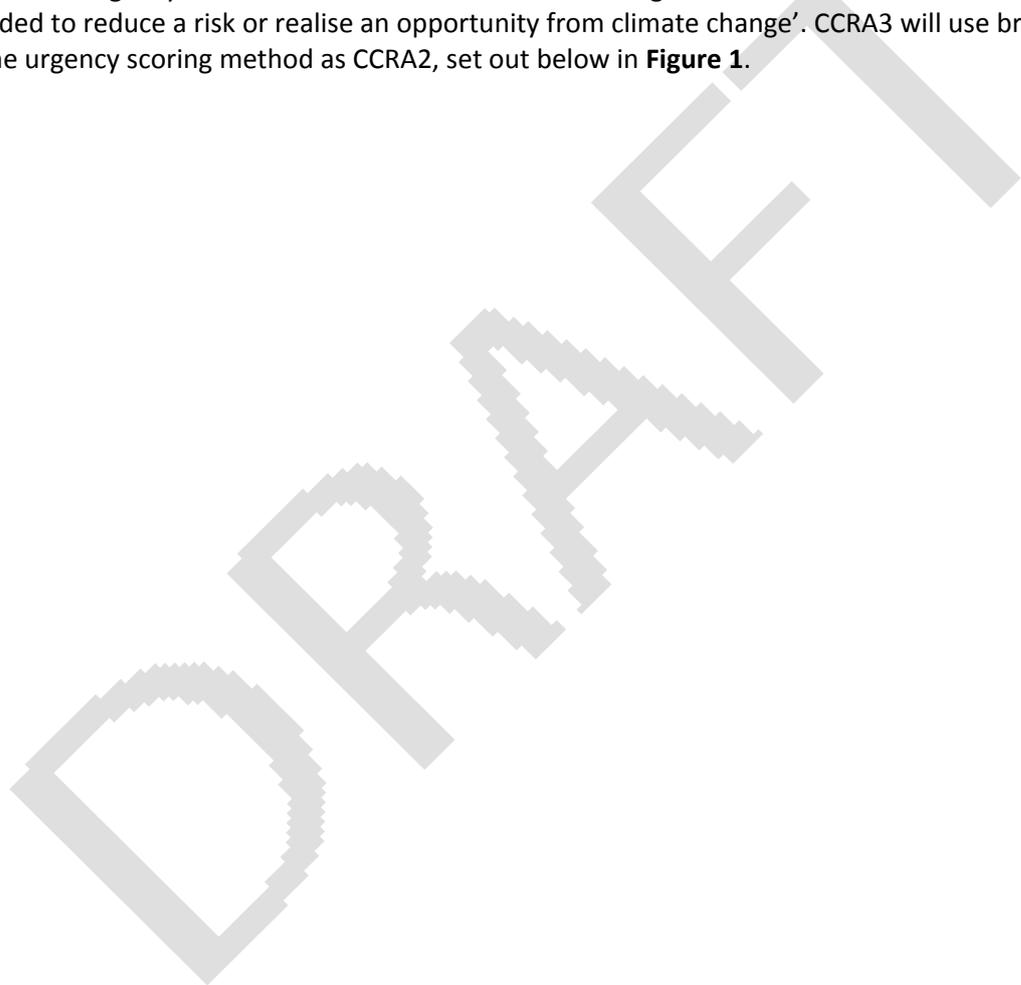
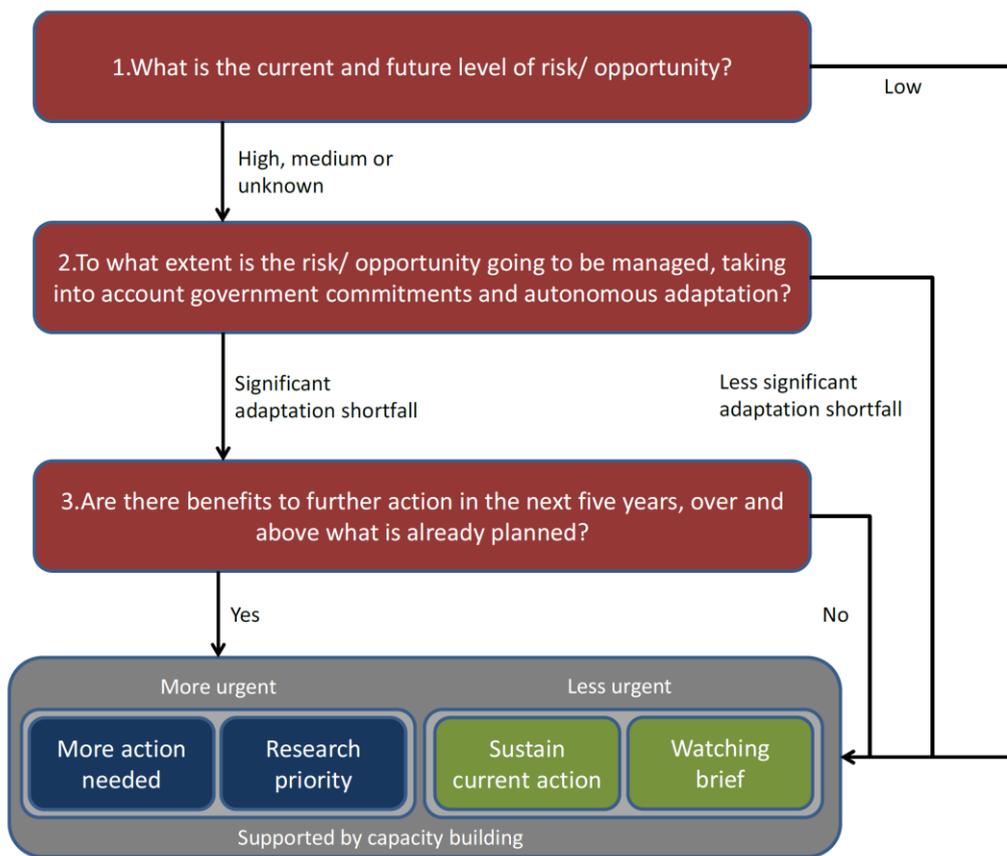


Figure 1: CCRA2 urgency scoring method and urgency categories



MORE URGENT ↑ ↓ LESS URGENT	MORE ACTION NEEDED	New, stronger or different government policies or implementation activities – over and above those already planned – are needed in the next five years to reduce long-term vulnerability to climate change.
	RESEARCH PRIORITY	Research is needed to fill significant evidence gaps or reduce the uncertainty in the current level of understanding in order to assess the need for additional action.
	SUSTAIN CURRENT ACTION	Current or planned levels of activity are appropriate, but continued implementation of these policies or plans is needed to ensure that the risk continues to be managed in the future. This includes any existing plans to increase or change the current level of activity.
	WATCHING BRIEF	The evidence in these areas should be kept under review, with long-term monitoring of risk levels and adaptation activity so that further action can be taken if necessary.

Sources: Adaptation Sub-Committee (2016) *UK Climate Change Risk Assessment 2017 Synthesis report: priorities for the next five years*, and Warren et al. (2016) *UK Climate Change Risk Assessment Evidence Report: Chapter 2, Approach and Context*.

In each technical chapter, the project team will assess urgency for each risk and opportunity identified. The assessment of urgency is broken down into three parts:

1. An assessment of the 'baseline' level of current and future (up to 2100) nature of the risk or opportunity (which would include an assessment of the uncertainty range of the magnitude of risk in the future), assuming that present-day levels of adaptation continue into the future.
2. An assessment of the extent to which current and planned adaptation will 'manage' the risk over the rest of the century.
3. An assessment of the benefits of further additional action in the next 5 years to manage the risk.

Step 1: What is the current and future level of risk?

The purpose of this step is to describe the risk today, and The assessment of current risk will include an assessment of the current level of hazard, vulnerability and exposure, and any action being taken to manage the risk. The analysis of current and future risk should include:

- A collation of the evidence available (and new analysis where relevant) on the magnitude of the risk or opportunity now and in the future. While the analysis in the technical chapters can include a range of climate and socioeconomic scenarios, ideally the outputs should be summarised by magnitude for present day, the '2050s' (2040-2069) and '2080s' (2070-2099) in a 2°C and 4°C world, and under a consistent set of socioeconomic assumptions.
- A consideration of how adaptation action since 2012 has changed the current and future risk or opportunity.
- How the effects of different climate scenarios, socio-economic change and adaptation will affect the future risk or opportunity, and the uncertainty range. The level of adaptation in the future should be assumed to be a continuation of the current level, rather than an assumption that (possibly more ambitious) policy goals are met. The chapter consortium, ASC and CCRA Customer Group will need to agree what the assumptions on this baseline level of adaptation are.
- The range of possible future impacts should be quantified as far as possible and broken down by each UK country, and for different regions within each country (different geographical areas or types of area e.g. cities, the coast, rural areas).
- An assessment and quantification of any interactions among risks or opportunities currently and how these may alter in the future and what the net effects of these changes might be.

The result of this step should be a description of the magnitude of the risks/opportunities at present and in the future in terms of economic, environmental and social metrics (see **Table 2** below), taking into account the effects of climate, socioeconomic change and the current level of adaptation. The degree of confidence in the assessment should also be given.

For risks in steps 1 that have large or medium magnitude in a 2°C and 4°C world by the end of the century, or where the level of risk is unknown, the analysis proceeds to step 2.

Table 2: Magnitude categories

	High Magnitude	Medium Magnitude	Low Magnitude
Quantitative evidence	Major annual damage and disruption or foregone opportunities: ¹ £hundreds of millions damage or foregone opportunities, and/or Thousands of hectares/km of land lost or irreversibly damaged, ² and/or Millions affected, hundreds of deaths ³ or hundreds of people irreversibly harmed Changes to majority of UK's natural assets and their associated goods and services.	Moderate annual damage and disruption or foregone opportunities: £tens of millions damage, and/or Hundreds of hectares/km land lost or irreversibly damaged, and/or Hundreds of thousands affected, tens of deaths, or tens of people irreversibly harmed Changes to around half of UK's natural assets and their associated goods and services.	Minor damage and disruption or foregone opportunities: <ul style="list-style-type: none"> – Less than £10 million damage, and/or – Tens of hectares/km lost or irreversibly damaged, other reversible/localised damage occurs, and/or – Thousands affected, a few deaths, or a few people irreversibly harmed Changes to a minority of UK's natural assets and their associated goods and services.
Qualitative evidence	Expert judgement and widespread agreement across authors, ASC and peer reviewers suggest there is a possibility of impacts of the magnitude suggested above.		

¹ This could be an annual average or expected annual damages. Where there is evidence on a single event but not an annual average, authors should make a judgement on the magnitude of an annual event and state this in their assumptions.

² These values are based on the average value for a hectare of land in England that is estimated to be £21k (www.gov.uk/government/uploads/system/uploads/attachment_data/file/407155/February_2015_Land_value_publication_FINAL.pdf)

³ The implied value of number of deaths is broadly in line with the value of prevented fatalities and life years lost used by Government in the appraisal of policies. It should be noted that this applies to an 'average' prevented fatality, i.e. someone of average age and who is otherwise healthy. Where possible, the authors should consider the life years lost associated with each individual risk. The estimated life years can be multiplied by the recommended value in the Department for Health Guidance (£60k in 2009 prices) to arrive at a monetary value of the health impacts. This monetary value can then be used to attribute a magnitude score to the risk.

Step 2: To what extent is the risk going to be managed, taking into account Government commitments and autonomous adaptation?

The purpose of this step is to understand to what extent we can assume future planned (see **Box 1**) or autonomous adaptation, that will take place according to the available evidence, will manage the risks down to at or below the level of risk today. There should be a description of what future adaptation is assumed, and what the potential barriers to realising this are. From this, the assessment should describe whether there is likely to be a significant adaptation shortfall in the future. For the purpose of this assessment, it is judged that there is a not a significant adaptation shortfall if:

1. After consideration of Government commitments and autonomous adaptation action, the magnitude would be reduced to either a low magnitude category by 2100 or the risk stays at or falls below today's level if these actions take place, OR
2. Where there is no evidence, there is widespread agreement between the CCRA authors, ASC and peer reviewers that the key drivers of vulnerability/exposure to the risk would be managed in the future (up to 2100) to a greater extent, either because the market will incentivise appropriate action or because Government has commitments in place to do so (with reasons why), AND
3. Government commitments and autonomous adaptation in relation to the risk in question, or as a result of dealing with other risks, do not lead to maladaptation (see Box 1).

Where any of the criteria above do not apply, or where there is a lack of evidence or agreement, we conservatively assume that there would be a significant adaptation shortfall, and the risk will be taken to step 3.

Box 1: Autonomous adaptation and Government Commitments

Autonomous adaptation

The assessment of autonomous adaptation will need to consider the potential reductions in risk through the action of individual actors, the private sector, and at the aggregate level, e.g. from market adjustments.

Potential maladaptation - a key issue is to identify whether the autonomous adaptation that may occur is appropriate, i.e. from an economic perspective, it is socially optimal. As an example, the increase of air conditioning as a response to building overheating is a potential autonomous adaptation response, but it would increase energy and carbon emissions, and possibly exacerbate social inequalities, and thus would be a form of maladaptation. Likewise, some farm-level responses (e.g. increased irrigation and fertiliser use) may involve wider cross-sectoral trade-offs that necessitate a role for planned intervention. This assessment needs to also consider cases in which adaptation has unintended consequences, e.g. create lock-in, or increasing risks in other sectors or associated with other development or social objectives.

Government commitments

The assessment of Government commitments should consider firm policy goals and aspirations, both in relation to specific existing and announced climate or resilience policy but also broader policy interventions that will reduce climate vulnerability. Authors should report on the potential effects of delivery/non-delivery of the policy goal in the chapter narratives where there is evidence to support such a narrative.

Potential for maladaptation - similarly to autonomous adaptation, the assessment of Government commitments should consider whether these commitments have unintended consequences, e.g. create lock-ins, or increasing risks in other sectors or associated with other development or social objectives.

Step 3: Are there benefits of further action – over and above what is planned - in the next 5 years?

The purpose of this step is to understand, for risks for which there is an adaptation shortfall, whether additional actions to address the risk over the next five years would be beneficial, and in what way.

There may be benefits of different kinds of action within the next 5 years as follows:

- **Retain flexibility**, avoiding lock-in to a particular pathway over the next few decades, or

- Help to **create the right conditions** to adapt later (e.g. put in place measures for changes that have long lead times, or create the right institutional conditions to adapt later), or
- **Provide the early steps**, e.g. capacity building, research, monitoring, that will enable better decisions in the near future (next 5 years), especially in relation to longer-term major risks, i.e. to build early interventions within an iterative adaptive management framework, or
- Have benefits for managing a **wide range** of climate and non-climate related risks, or
- Are **cost-effective** to implement now.
- **Reduce vulnerability** now.

In order to undertake this step, chapter authors will need to make some high level assessment of the types of actions that could be employed to manage the risk. For CCRA3, we also want the benefits of further action to be **valued** as far as possible.

Labelling risks and opportunities by urgency

The end result of applying steps 1 – 3 is to label each risk and opportunity by urgency category. It is important to note that no risk or opportunity ‘falls out’ of the framework. Risks identified as urgent (‘more action needed’ or ‘research priority’) have a specific action in addition to monitoring assigned to them. Risks identified as less urgent (‘watching brief’ and ‘sustain current action’) require ongoing action and/or monitoring to see if the actions that should be happening, are happening. The UK Government and devolved administrations then need to decide what action to take to address the risks and opportunities. The effect of the National Adaptation Programme in reducing these risks and realising opportunities for England will be evaluated within the ASC’s statutory evaluation role.

Confidence

In summarising the evidence in the technical chapters, authors need to assign a confidence score to each step in the urgency framework. The confidence score represents the overall quality of the evidence base that has been used to arrive at the decision on urgency. **Table 3** below provides criteria to be used to assign a confidence score to each risk and opportunity assessed.

Table 3: Confidence criteria			
	High confidence	Medium confidence	Low confidence
Step 1: Assessment of current and future risk	Multiple sources of independent evidence based on reliable analysis and methods, with widespread agreement between studies and experts.	Several sources of high quality independent evidence, with some degree of agreement between studies, and/or widespread agreement between experts.	Varying amounts and/or quality of evidence and/or little agreement between experts, or assessment is made using only expert judgement.
Step 2: Assessment of the effect of planned and autonomous adaptation	High quality evidence of the effects of future adaptation in managing the risk and high agreement between experts.	Some evidence on the effects of future adaptation in managing the risk and/or high agreement between experts.	Little/no/contrasting evidence of the effects of future adaptation in managing the risk and little agreement between experts, or assessment is made using only expert judgement.

Step 3: Assessment of whether additional action would be beneficial	High quality evidence of benefits of future adaptation on risk and high agreement between experts.	Some evidence on benefits of future adaptation and/or high agreement between experts.	Little evidence of the benefits of future adaptation and little agreement between experts, or assessment is made using only expert judgement.
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For the purpose of this assessment the following criteria in **Table 4** should be considered in the assessment of the quality of evidence.

Table 4: Quality of evidence criteria		
High quality evidence	Some evidence	Little evidence
<ul style="list-style-type: none"> • Multiple sources of evidence that contain similar results • Based on robust techniques • Data used is of a high quality • Evidence has been peer reviewed • Published relatively recently 	<ul style="list-style-type: none"> • Some elements of “high quality evidence” and “little evidence” 	<ul style="list-style-type: none"> • No, or very few, sources of evidence • Based on weak methodologies (e.g. anecdotal evidence) • Poor quality data • Evidence has not been peer reviewed • Published a long time ago

Treatment of likelihood and uncertainty

The conventional definition of risk, which applies in economics, engineering and decision analysis, is a combination of probability and consequence.

Most risk assessments and risk registers that deal with present-day risks try to define the likelihood and impact of that risk occurring. This is the approach adopted through the National Risk Register and in the Environment Agency’s National Flood Risk Assessment, for example. The same approach is adopted in the insurance industry, where it is conventional to think of risk in terms of hazard, exposure and vulnerability.

The same framework of likelihood and impact can be used to calculate risks in the future, recognising that the factors that influence risk will change in future. This conventional risk assessment framework is the approach that will be adopted, as far as is feasible, within CCRA3. For some risks (e.g. flood risk) we will be able to calculate the expected damages at present and in a range of future conditions. For others, the necessary models do not exist, but we will seek to conform to the same conceptual framework.

However, climate change risk assessment brings new sources of uncertainty, alongside the natural variability that we conventionally deal with by using probabilities in risk assessment. There is uncertainty about the scale of future changes in climate and socio-economic factors, as well as adaptation responses. All of these future changes, which will potentially significantly modify risk in future, are uncertain.

There are a number of ways in which (uncertain) future risks may be presented.

1. As a range of future risks: “The expected annual damage due to flooding in 2050 will be in the range £x billion to £y billion.”

2. As a range of future impacts, with accompanying qualitative likelihood statement: “Coastal retreat in East Anglia is projected to be a High magnitude, but with Low confidence, given a 4 degree world in the 2080s, high socioeconomic change and no additional adaptation”. This includes a qualitative statement of the severity of future impact and a qualitative confidence statement about the likelihood of future change. It is conditional upon stated assumptions about climate, socio-economics and adaptation.
3. As the change in probability of a specified event: “The likelihood of a heatwave as severe as 2003 will change from 1 in 50 years to 1 in 2 years by 2040 under a medium emissions scenario.” This statement says nothing about the future impacts of such an event; nor does it say anything about the uncertainty in the projection. It may be useful evidence but it is not a risk assessment.

Risk descriptors

There are a number of different ways that risks and opportunities can be ‘cut’. **Table 5** lists the risk and opportunity descriptors used in CCRA2; there are likely to be a similar number for CCRA3 but the final list is not yet decided:

Table 5: List of risk descriptors (including opportunities) covered in the CCRA2 Evidence Report	
Chapter	Risk descriptor (with relevant chapter sections in brackets)
3	Ne1: Risks to species and habitats due to inability to respond to changing climatic conditions (Section 3.2)
3	Ne2: Opportunities from new species colonisations (3.2)
3	Ne3: Risks and opportunities from changes in agricultural and forestry productivity and land suitability (3.3)
3	Ne4: Risks to soils from increased seasonal aridity and wetness (3.3)
3	Ne5: Risks to natural carbon stores and carbon sequestration (3.3, 3.7)
3	Ne6: Risks to agriculture and wildlife from water scarcity and flooding (3.4)
3	Ne7: Risks to freshwater species from higher water temperatures (3.4)
3	Ne8: Risks of land management practices exacerbating flood risk (3.3, 3.4)
3	Ne9: Risks to agriculture, forestry, landscapes and wildlife from pests, pathogens and invasive species (3.7)
3	Ne10: Risks to agriculture, forestry, wildlife and heritage from changes in frequency and/or magnitude of extreme weather and wildfire events (3.3)
3	Ne11: Risks to aquifers, agricultural land and habitats from saltwater intrusion (3.5)
3	Ne12: Risks to habitats and heritage in the coastal zone from sea-level rise; and loss of natural flood protection (3.5)
3	Ne13: Risks to, and opportunities for, marine species, fisheries and marine heritage from ocean acidification and higher water temperatures (3.6)
3	Ne14: Risks and opportunities from changes in landscape character (3.7)
4	In1: Risks of cascading failures from interdependent infrastructure networks (Sections 4.4 to 4.9)
4	In2: Risks to infrastructure services from river, surface water and groundwater flooding (4.4 to 4.9)
4	In3: Risks to infrastructure services from coastal flooding and erosion (4.4 to 4.9)

Table 5: List of risk descriptors (including opportunities) covered in the CCRA2 Evidence Report

Chapter	Risk descriptor (with relevant chapter sections in brackets)
4	In4: Risks of sewer flooding due to heavy rainfall (4.5)
4	In5: Risks to bridges and pipelines from high river flows and bank erosion (4.5, 4.7, 4.8)
4	In6: Risks to transport networks from slope and embankment failure (4.7)
4	In7: Risks to hydroelectric generation from low or high river flows (4.8)
4	In8: Risks to subterranean and surface infrastructure from subsidence (4.5, 4.6, 4.7, 4.8)
4	In9: Risks to public water supplies from drought and low river flows (4.5)
4	In10: Risks to electricity generation from drought and low river flows (4.8)
4	In11: Risks to energy, transport and digital infrastructure from high winds and lightning (4.6, 4.7, 4.8)
4	In12: Risks to offshore infrastructure from storms and high waves (4.7, 4.8)
4	In13: Risks to transport, digital and energy infrastructure from extreme heat (4.6, 4.7, 4.8)
4	In14: Potential benefits to water, transport, digital and energy infrastructure from reduced extreme cold events (4.5, 4.6, 4.7, 4.8)
5	PB1: Risks to health and wellbeing from high temperatures (Sections 5.2.2, 5.3.2, 5.5.3)
5	PB2: Risks to passengers from high temperatures on public transport (5.3.9)
5	PB3: Opportunities for increased outdoor activities from higher temperatures (5.2.3)
5	PB4: Potential benefits to health and wellbeing from reduced cold (5.3.3, 5.5.4)
5	PB5: Risks to people, communities and buildings from flooding (5.2.5, 5.3.4, 5.5.1)
5	PB6: Risks to the viability of coastal communities from sea level rise (5.2.6, 5.2.7)
5	PB7: Risks to building fabric from moisture, wind and driving rain (5.3.4, 5.3.6, 5.3.7)
5	PB8: Risks to culturally valued structures and the wider historic environment (5.3.8)
5	PB9: Risks to health and social care delivery from extreme weather (5.4)
5	PB10: Risks to health from changes in air quality (5.2.2, 5.3.5, 5.5.5)
5	PB11: Risks to health from vector-borne pathogens (5.5.2)
5	PB12: Risk of food borne disease cases and outbreaks (5.5.6)
5	PB13: Risks to health from poor water quality (5.5.6)
5	PB14: Risk of household water supply interruptions (5.2.4)
6	Bu1: Risks to business sites from flooding (6.2.2, 6.2.3)
6	Bu2: Risks to business from loss of coastal locations and infrastructure (6.2.2, 6.2.3)
6	Bu3: Risks to business operations from water scarcity (6.2.4, 6.2.5) NB: Also see related infrastructure risk In9.
6	Bu4: Risks to business from reduced access to capital (6.3)
6	Bu5: Risks to business from reduced employee productivity, due to infrastructure disruption and higher temperatures in working environments (6.4.2, 6.4.3, 6.4.4, 6.4.5)

Table 5: List of risk descriptors (including opportunities) covered in the CCRA2 Evidence Report

Chapter	Risk descriptor (with relevant chapter sections in brackets)
6	Bu6: Risks to business from disruption to supply chains and distribution networks (6.5) NB: Also see related international risks It1 and It3.
6	Bu7: Risks and opportunities for business from changes in demand for goods and services (6.6)
7	It1: Risks from weather-related shocks to international food production and trade (Section 7.2)
7	It2: Imported food safety risks (7.2)
7	It3: Risks and opportunities from long-term, climate-related changes in global food production (7.2)
7	It4: Risks to the UK from climate-related international human displacements (7.3)
7	It5: Risks to the UK from international violent conflict (7.4)
7	It6: Risks to international law and governance (7.4)
7	It7: Opportunities from changes in international trade routes (7.4)

6. Assumptions on degree of future climate change

In assessing the risks and opportunities, a range of assumptions based on what is available in the wider evidence base can be used. However, we intend to summarise the level of risk or opportunity for the present day, 2050s and 2080s for two climate scenarios; a global temperature rise roughly equivalent to a 2°C and 4°C increase above pre-industrial levels by the end of the century.

This approach gives us flexibility to use studies based both on the older Special Report on Emissions Scenarios (SRES) and newer Representative Concentration Pathways (RCP) scenarios. Stakeholder feedback suggests that it is also much easier for readers to understand the translation from emissions to temperature, and provides a clearer link to how UK climate risks would vary with different levels of global greenhouse gas emissions reductions. UKCP18 will give projections of change for time periods, and also for changes equivalent to 2°C and 4°C scenarios. The technical chapters will need to find a way to present, as far as possible, the risks and opportunities for these two scenarios robustly in the summary for each chapter.

7. Assumptions of future socio-economic change

Chapter authors should record what socio-economic assumptions have been made for the assessment of magnitude in 'step 1' of the urgency framework, using in part the results of the socioeconomic dimensions research project.

Changes in society and the economy will be important determinants of the magnitude of the risks and opportunities considered in the evidence report. Chapter authors should define in quantitative terms what socio-economic assumptions have been made for each piece of evidence. The ASC has commissioned research to develop a consistent set of socioeconomic dimensions for the CCRA3 research projects. Chapter authors should make reference to these dimensions and use them where appropriate. This may be challenging given that much of the evidence may come pre-packaged with socio-economic assumptions, though these assumptions are often only about population change which is generally derived from the same set of ONS projections.

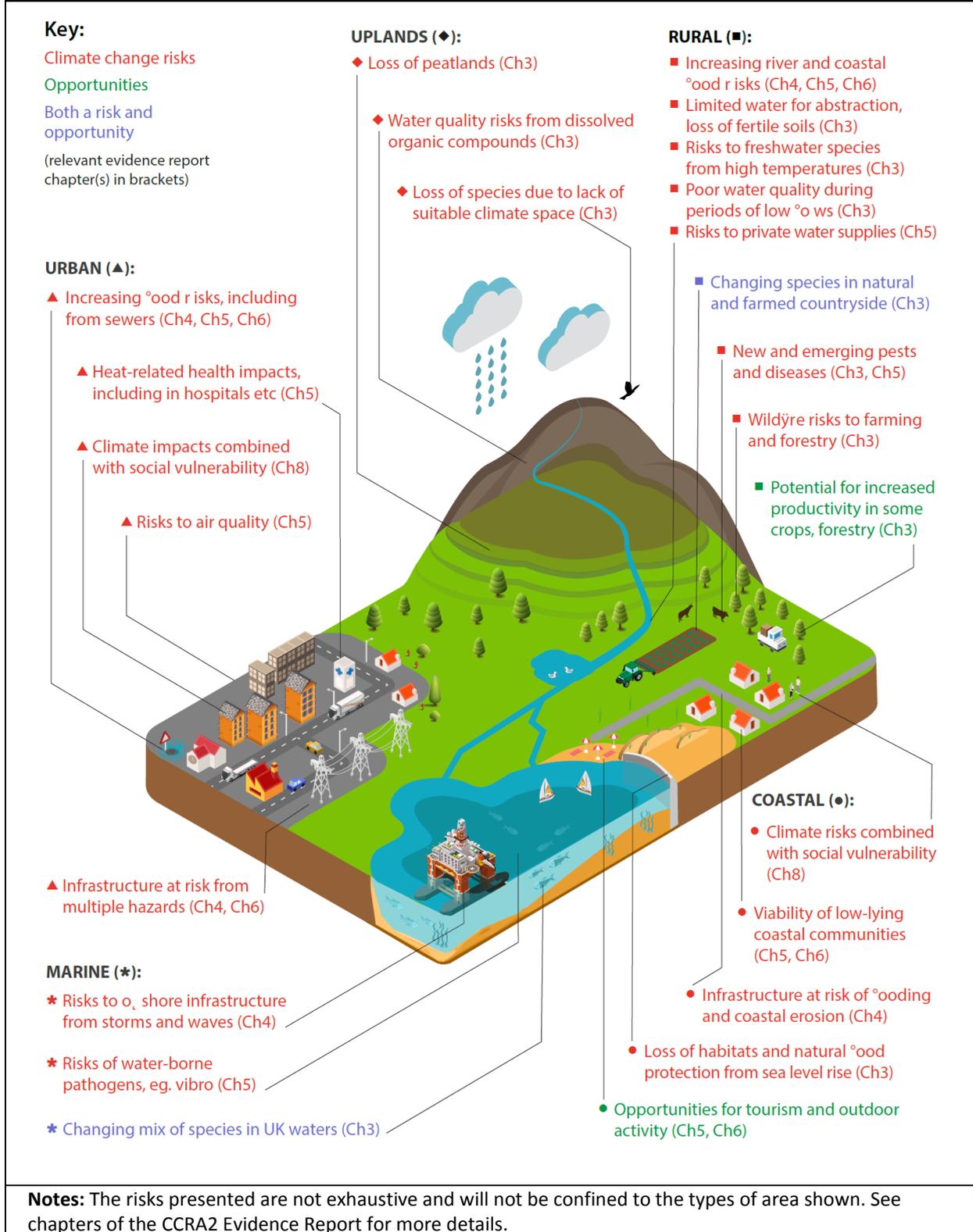
8. Using a place-based systems approach

The Government customer requirement states that CCRA3 should use a more **systems-based approach** to take better account of interdependencies and interactions (e.g. through making assessments for appropriate **place-based systems** such as coasts and cities). CCRA3 will therefore be considering systems in two ways:

1. By further exploring how risks interact in each chapter, in part through using the results of the Interacting Risks research project.
2. By summarising the results of CCRA3 for different places rather than sectors through the summary briefing notes.

Drawing on evidence from across the chapters, CCRA2 summarised the results of the risk assessment for England, Wales, Scotland and Northern Ireland. It also attempted to illustrate how different risks could be distributed among different types of area including urban, marine, uplands, rural and coastal (see **Figure 2**). However, this was not done in a systematic way across chapters and risks and opportunities were not quantified for comparisons within and among the different area types.

Figure 2: UK climate change risks and opportunities for different types of area



There are a number of ways in which to split areas or land types depending on the nature of the statistics being collected or assessment being undertaken. Based on reviewing these and requirements for CCRA3, as well as summarising risks by country, the area types that chapter authors should consider and that will be made into separate summary briefings are:

- Coastal;
- Marine;
- Rural lowlands;
- Uplands; and
- Urban.

9. Quality assurance

Two overarching **governance** groups will be responsible for the overall production of the Evidence Report and Government Report:

1. A CCRA3 Customer Group, chaired by the Chair of the ASC and including representatives from Defra and the devolved administrations, will oversee the evidence report.
2. Defra will retain formal oversight for the Government Report for CCRA3 and will chair a project board of experts from the devolved administrations, Environment Agency and other government departments, including any government stakeholders that sit on the ASC's expert steering groups.

A **call for evidence** will be made in early 2019 to provide anyone with the opportunity to submit evidence.

There will be **peer review** processes put in place across the different parts of CCRA3:

- Each of the research projects will provide draft methods and/or reports to an expert steering group and a technical peer review group, and will document how they have addressed each of the review comments in an annex of the report or separate spreadsheet.
- For the technical chapters there will be three separate review periods. Each review will involve:
 - Peer review – each chapter will be reviewed by two to three subject experts;
 - Government stakeholder review – Defra's project board and the Customer Group will identify representatives from government departments and those of the devolved administrations, as well as other agencies, public bodies and regulators to review the chapters;
 - External review - the ASC will invite particular local government, non-government organisations and representatives from the private sector to review specific chapters.

All comments will be logged in an excel spreadsheet and the chapter authors will provide responses in each case.